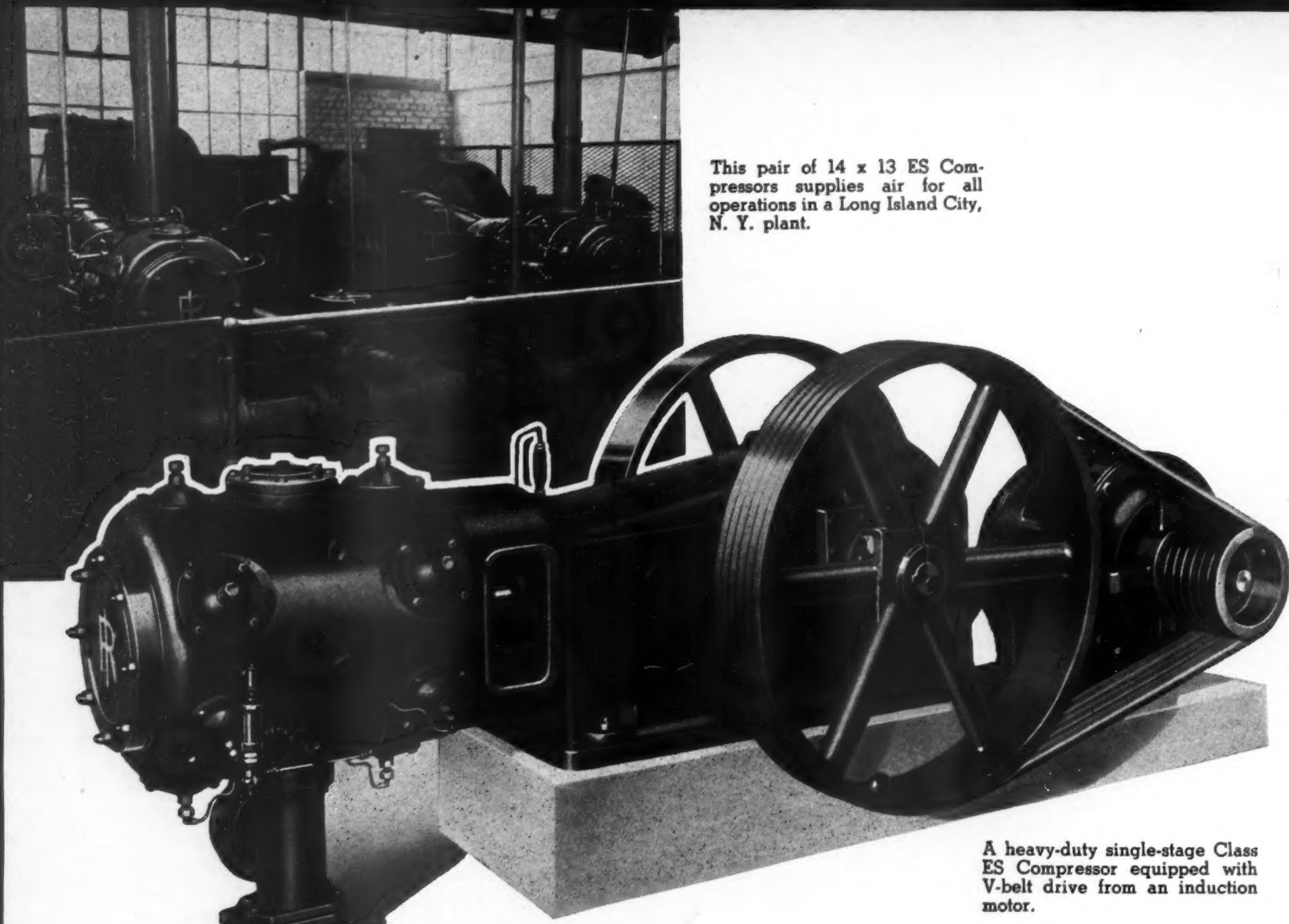
Compressed Air Magazine

VOLUME 47 · NUMBER 1 JANUARY 1942 LONDON · NEW YORK · PARIS

MACHINERY IN OLD MINT AT POTOSI, BOLIVIA



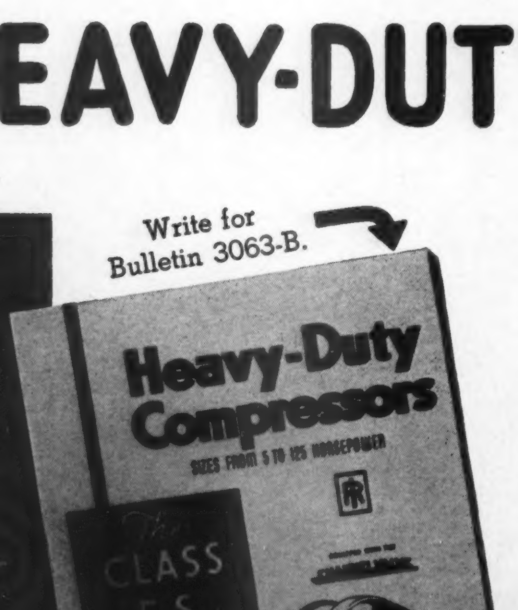
This pair of 14 x 13 ES Compressors supplies air for all operations in a Long Island City, N. Y. plant.

A heavy-duty single-stage Class ES Compressor equipped with V-belt drive from an induction motor.

BUSY SHOPS DESERVE

HEAVY-DUTY COMPRESSORS

Write for Bulletin 3063-B.



OTHER

PRODUCTS

- Aftercoolers
- Blowers
- Core Drills
- Compressors
- Condensers
- Engines
- Hoists
- Pneumatic Tools
- Pumps
- Receivers
- Rock Drills
- Vacuum Pumps

Peak plant performance and 'round-the-clock operation provide problems enough without added worry and annoyance due to worn-out or inadequate equipment.

It will pay you to put your trust in efficient heavy-duty machines, such as Ingersoll-Rand's horizontal double-acting Class ES Compressor. Built in 5 to 125 hp sizes, this unit is designed throughout for long periods of uninterrupted, full-load service.

With double-row Timken roller main bearings and quiet, cushioned Channel Valves, Class ES units operate with exceptionally high economy. Full accessibility for quick adjustments is provided by large top frame covers.

Ingersoll-Rand

11 BROADWAY, NEW YORK CITY 1-106

Branches or Distributors in other Principal cities the world over.

Atlanta, Birmingham, Boston, Buffalo, Butte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Duluth, El Paso, Hartford, Houston, Kansas City, Knoxville, Los Angeles, Newark, New Orleans, New York, Philadelphia, Picher, Pittsburgh, Pottsville, Salt Lake City, San Francisco, Scranton, Seatt[le], St. L[ouis], Tuls[a], Wa[shington]

ON THE COVER

BETWEEN 1547 and 1864, Potosi, Bolivia, located at an elevation of 13,612 feet, produced $2,000,000,000 in silver. Much of it was made into pieces of eight and other Spanish coins in the old "royal mint" that dates from 1585. The machinery was originally run by slaves, who turned a capstan bar on the floor below the one pictured on our cover. Potosi's onetime population of 160,000 has now dwindled to about 40,000. Much of the surrounding area is being remined for tin.

•

IN THIS ISSUE

NATURAL gas is rightfully included among our greatest natural resources. No other nation has it in such abundance, and none transports it as far as we do to reach industrial and domestic markets. Our leading article presents some pertinent information concerning the scope of the natural-gas industry and describes the world's longest transmission line.

•

THE author of *Fiji Gold*, John Cramer-Roberts, began writing the article in January, 1940, and completed it early in 1941. The manuscript then went to Australia to be typed and reviewed by officials of the Associated Companies. It reached us late last year. It describes the Fiji gold-mining industry as it was at the end of 1940. Shortly after completing the manuscript, Mr. Cramer-Roberts left Fiji to take up new work for a company that is seeking to develop gold deposits in the Solomon Islands.

•

SOMETHING new has been added to the technology of iron melting. It is the practice of controlling the weight of oxygen in the cupola blast. Doing this has definite beneficial effects, and modern foundries have been quick to avail themselves of its advantages. An article by W. H. O'Connell describes the application of this principle in a New Jersey foundry.

•

THE demand for quicksilver is as mercurial as the metal; but the gathering of war clouds is always a signal for the resumption of operations in old mines that have difficulty showing a profit under peacetime conditions. One such property is the Great Western Mine, the current operation of which is described by Worthen Bradley, president of the company in charge. Incidentally, Mr. Bradley is perhaps our most versatile contributor, for two of his humorous cartoons have previously been published in these pages.

Compressed Air Magazine

Volume 47 **January, 1942** Number 1

C. H. VIVIAN, *Editor*
A. M. HOFFMANN, *Assistant Editor*
J. W. YOUNG, *Advertising Manager*
J. F. KENNEY, *Business Manager*
D. Y. MARSHALL, *European Correspondent*, 243 Upper Thames St., London, E.C.4.
F. A. MCLEAN, *Canadian Correspondent*, New Birks Bldg., Montreal, Quebec.

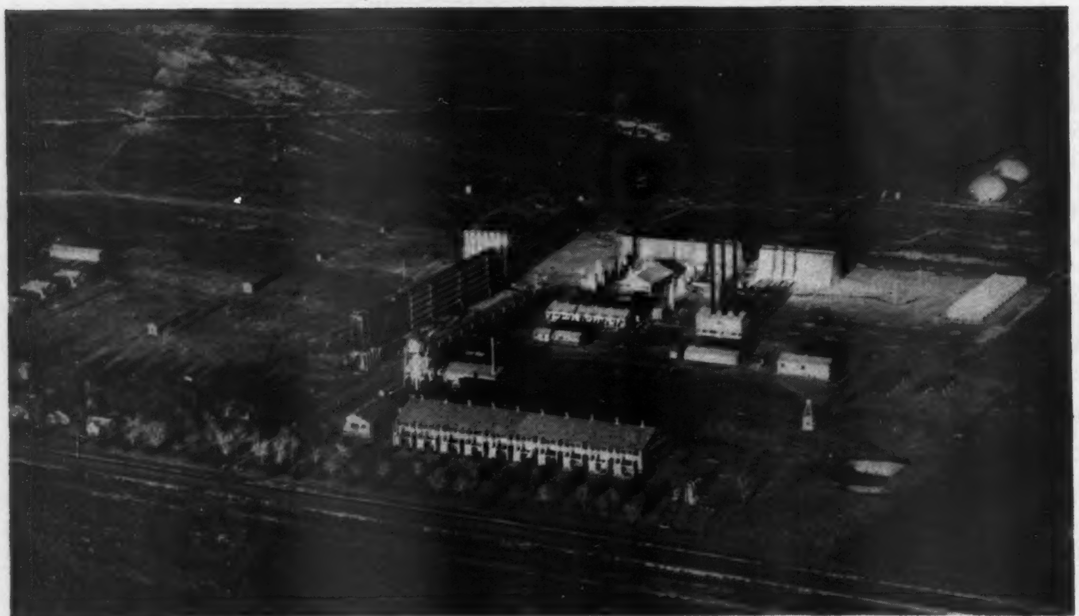
EDITORIAL CONTENTS

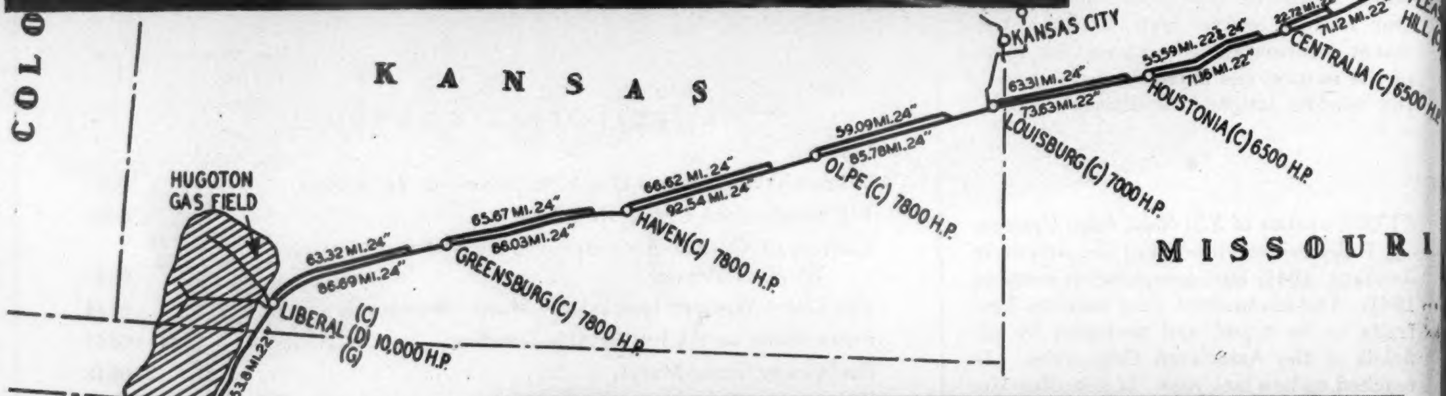
ADVERTISING INDEX

A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

CCA Member Controlled Circulation Audit.

Published by Compressed Air Magazine Company. G. W. MORRISON, president; J. F. KENNEY, vice-president; F. E. KUTZ, secretary-treasurer.
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York, N. Y., L. H. GEYER, representative.
Annual subscription price: domestic, $3.00; foreign, $3.50. Single copies, 35 cents.
Compressed Air Magazine is on file in many libraries and is indexed in Industrial Arts Index.





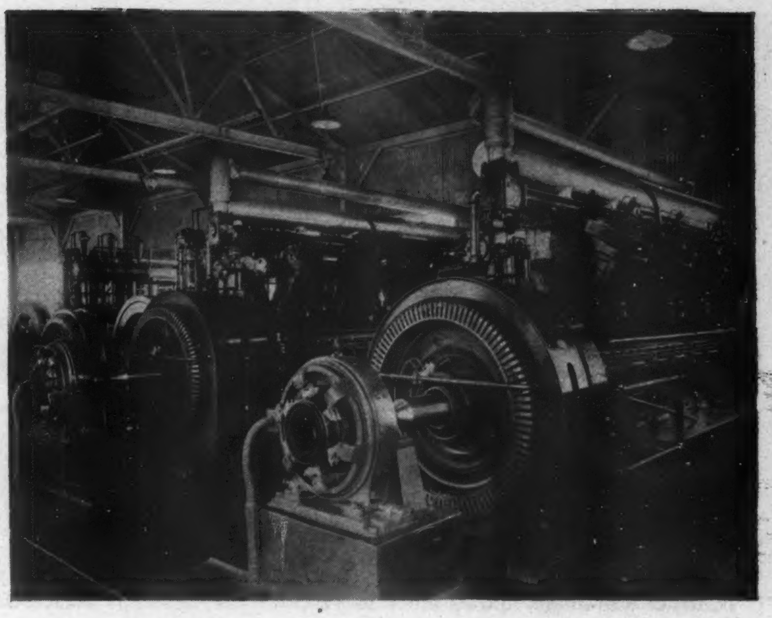
ROUTE OF LINE AND VIEWS OF LIBERAL STATION

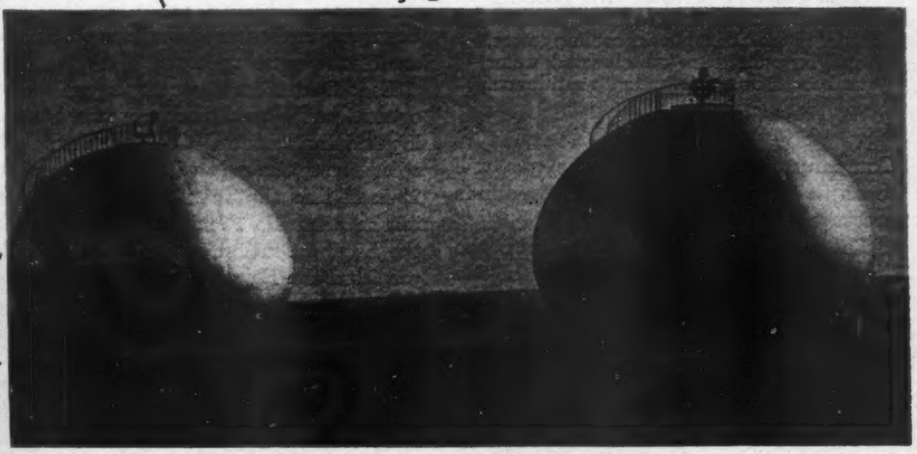
Although the line is continuous from Texas to Detroit, it is operated to the Indiana line by the Panhandle Eastern Pipe Line Company and from there to Detroit by the Michigan Gas Transmission Company. The letters C, D, and G in parentheses and following the names of stations denote, respectively, compressor, dehydration, and gasoline extraction. At the top, left, is an aerial view of the Liberal, Kans., station, the largest of the twelve on the Panhandle line. The main compressor building is seen at the right. The exhaust mufflers of the main engines are at the side of the structure and are equipped for cooling with air which, in winter, is drawn from within the building by blowers and then returned to it for heating the interior. The lower view on the opposite page shows two Hortonspheres in which is stored the gasoline that is extracted from the gas at this station. Power for the latter is furnished by three 250-kw. generators direct-driven by 8-cylinder PVG gas engines. Two of these units are pictured at the upper right.

THE natural-gas industry of the United States is larger than most persons realize. At the close of 1940 there was invested in it the sum of $2,414,-490,000, which is nearly double the capital employed in the manufacture of automobiles. Natural gas is available in 34 states, and the areas in which it is distributed have an aggregate population of 35,000,000. Last year 7,824,000 domestic, industrial, and commercial customers used 1,441,692 million cubic feet, for which they paid $492,717,000. In addition, more than 1,100,000 million cubic feet was consumed in the production of carbon black and in the operations of the companies both producing and distributing the gas.

Compared with manufactured gas, natural gas served about 2,300,000 fewer persons in 1940, but the volume distributed was more than three times as great and the revenue derived from it was $113,000,000 higher. The reason for the relatively greater volume of natural gas per customer is that it is used in huge amounts by some industrial concerns. In fact, last year 47,000 industrial customers consumed 42 per cent more natural gas than 7,212,000 domestic customers, although the latter accounted for 57 per cent of the revenue realized by the distributing utilities. Thousands of proc-

ittitural Gas 1155 Miles





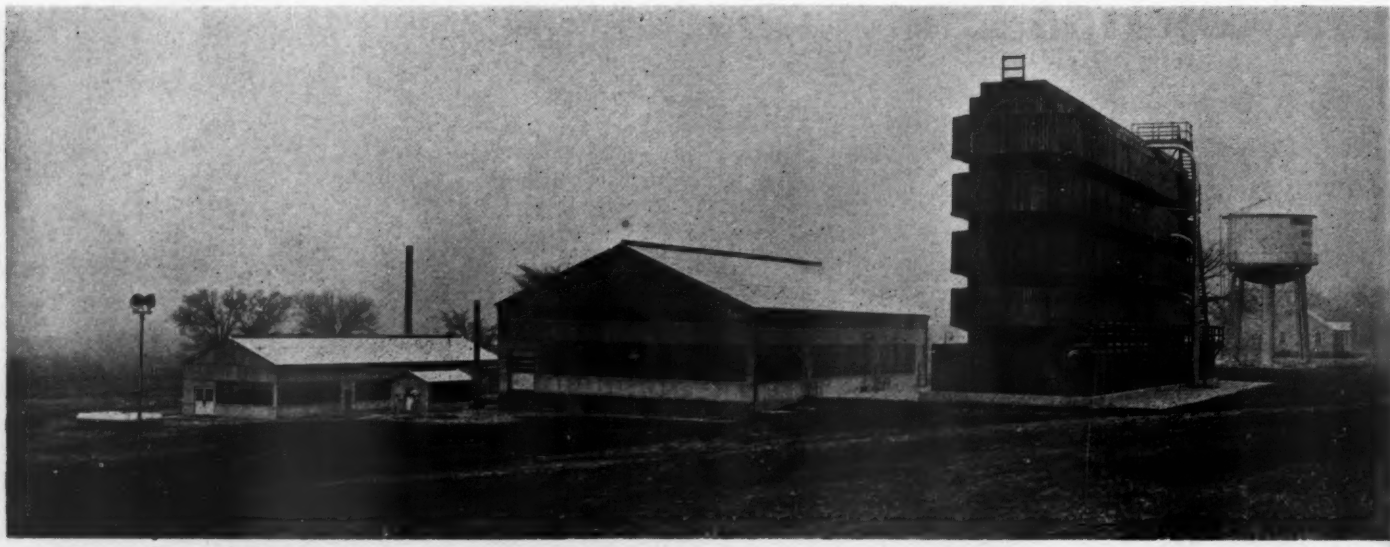
esses, ranging from the manufacture of cement and glass to the tempering of pen points and watch springs, make use of gas.

Natural-gas fields are found in 24 states. Some yield oil as well as gas, but in most states the production of gas is restricted to conserve the pressure for lifting the oil to the surface. The largest strictly gas fields are the Amarillo in the Texas Panhandle, the adjoining Hugoton just north of it, and the Monroe in northern Louisiana. The production, transportation, and distribution of natural gas give employment to about 70,000 persons. From the wells, the gas is run through small gathering lines to a central point and there transferred to a main-line transmission system. During the past decade there has been an enormous expansion in the construction of transmission lines, and they now have a total length of 195,130 miles and range from 6 to 26 inches in diameter. Each of them is designed to operate at a given maximum pressure, and long lines have intermediate compressor stations to restore the pressure drop occasioned by friction. The demand for gas in any community fluctuates widely with the rise and fall in industrial activity, as well as seasonally. As gas is extensively used for househeating, the consumption ordinarily reaches its peak during the coldest weather of the year. Production, transmission, and distribution facilities must, of course, be gauged to meet this maximum demand, although during a considerable part of the year there may be a large reserve capacity that is not required.

The nation's first natural-gas transmission line extended 25 miles from Bloomfield to Rochester in New York State. It was made up of wood pipe, from 2 to 8 feet long, with the plain end of one fitted into the belled end of its neighbor, the joint being bound with a metal strap and sealed with hot tar. The sections were made by turning logs of Canadian white pine to an external diameter of 12½ inches and boring an 8-inch hole through them. This line obviously was designed to operate under low pressure. The first high-pressure transmission was accomplished in 1891, when two parallel 8-inch lines were laid between Greentown, Ind., and Chicago, Ill., a distance of 120 miles. They were built of wrought-iron sections with screw joints, and the system was operated under 525 pounds pressure. Wrought iron was the accepted material for gas lines until about 1900, when steel came into general use and reduced the cost of pipe by about one-half.

One of the longest gas transmission lines in the world extends 1,155 miles from near Amarillo, Tex., to Detroit, Mich. From Texas to the Illinois-Indiana border, a distance of 856 miles, it is operated by the Panhandle Eastern Pipe Line Company: the remaining 299 miles of it is operated by the Michigan Gas Transmission Corporation. Construction was started at its western end in 1930 by the Panhandle Eastern Pipe Line Company. Before much work had been done, the Columbia Oil & Gasoline Corporation acquired 50 per cent of the common stock and all the bonds of that company; and thereafter the additional funds to complete the line were furnished half by the Columbia organization and half by the Missouri-Kansas Pipe Line Company, the owner of the other half of the common stock. The line was then run into Indiana and connected with lines of the Columbia system.

In 1935, Panhandle contracted to deliver to the Detroit City Gas Company not more than 90,000,000 cubic feet of gas daily. Subsequently it made an agreement with the Michigan Gas Transmission Corporation to furnish the latter with gas to meet the Detroit contract, plus additional quantities to serve customers at intermediate points. The Michigan Gas Transmission Corporation took over the part of the Panhandle line extending from the Illinois boundary to Zionsville, Ind., and built 230 miles of new line from the latter place to Detroit. Delivery of gas to Detroit was started on July 9, 1936. Panhandle then discontinued supplying gas to the Columbia system in Ohio, although the connecting link was not removed and is still in place. The consumption of gas in Detroit has increased since the original



TYPICAL COMPRESSOR STATION

This station at Pleasant Hill, Ill., is similar to all those east of Texas. The main building, housing five 1,300-hp. compressors, is in the center. At the right is the atmospheric cooling tower, and beyond it are an elevated water tank and the superintendent's residence.

contract was made, and as much as 125,000,000 cubic feet has been delivered to that city in one day. During the past summer, Panhandle arranged with the Consumers Power Company to send gas to Flint and some 80 other Michigan cities that do not have facilities to manufacture artificial gas in sufficient quantities to meet current increased demands. Along its main line, Panhandle sells gas to distributing companies that retail it in Kansas, Missouri, and Illinois, and it also sells smaller amounts direct to industrial consumers. Deliveries in Illinois are made by the Illinois Natural Gas Company, a wholly owned subsidiary.

The gas, which has about 1,000 Btu's per cubic foot and a specific gravity of 0.69, is obtained from wells in the Amarillo and Hugoton gas fields. The former is in Texas, while the latter lies partly in Texas, Oklahoma, and Kansas. The Panhandle company produces approximately 50 per cent of the gas it transmits and buys the remainder from independent producers. In the two fields, it owns gas and oil leaseholds on some 270,000 acres and controls approximately 60,000 additional acres through gas-purchase contracts. Underlying these lands are reserves of gas estimated to be sufficient to supply the system for 25 years.

The wells have an average depth of 2,800 feet. The gas is produced under a pressure of 250 to 275 pounds in the Amarillo Field and of around 360 pounds in the Hugoton Field. It flows through networks of gathering lines to the main transmission system. The latter is operated under a pressure of 500 pounds, which is maintained by recompressing the gas at stations about 80 miles apart. There are twelve of these stations, containing a total of 83,000 hp. of gas-engine-driven compressors, on the Panhandle line: on the part operated by the Michigan Gas Transmission Company there are three compressor stations and the pressure ranges as high as 575 pounds. The contract with the Detroit City Gas Company guarantees that the gas will reach that city under at least 100 pounds pressure.

The map on pages 6627-28 shows the location and installed horsepower of the Panhandle stations and also the route of the line and the size of pipe used in the different sections. A single 22-inch line of 105 miles extends from the Amarillo Field to Liberal, Kans., where gas comes in from the Hugoton Field. From that point eastward to the Indiana boundary there are 351 miles of 24-inch, 342 miles of 22-inch, and 58 miles of 20-inch line. It will be noted that eastward of Liberal the line is double for a part of the distance between each pair of adjacent compressor stations. These additional lines, which are known as loops, provide means for increasing the capacity without raising the pressure beyond that which the system is designed to carry. With each rise in the demand for gas, the loops are extended; and it is apparent that there will eventually be a double line all the way if this practice is continued. At present, approximately 70 per cent of the line from Liberal eastward is looped. It has a sales capacity of approximately 250,000,000 cubic feet a day.

When the line was first placed in operation, three compressor stations of 14,000-hp. aggregate capacity sufficed to push through it all the gas that was required. These stations were located at Liberal and Louisburg, Kans., and Glenarm, Ill. Each was equipped with 1,000-hp., horizontal, direct-connected gas-engine-driven compressors, and identical units were added as demand warranted. In eight of the nine other stations that were subsequently built to increase the capacity of the line were installed 1,300-hp. units generally similar in design to the 1,000-hp. machines. All additional units that have been put in these stations since then also are of the same type.

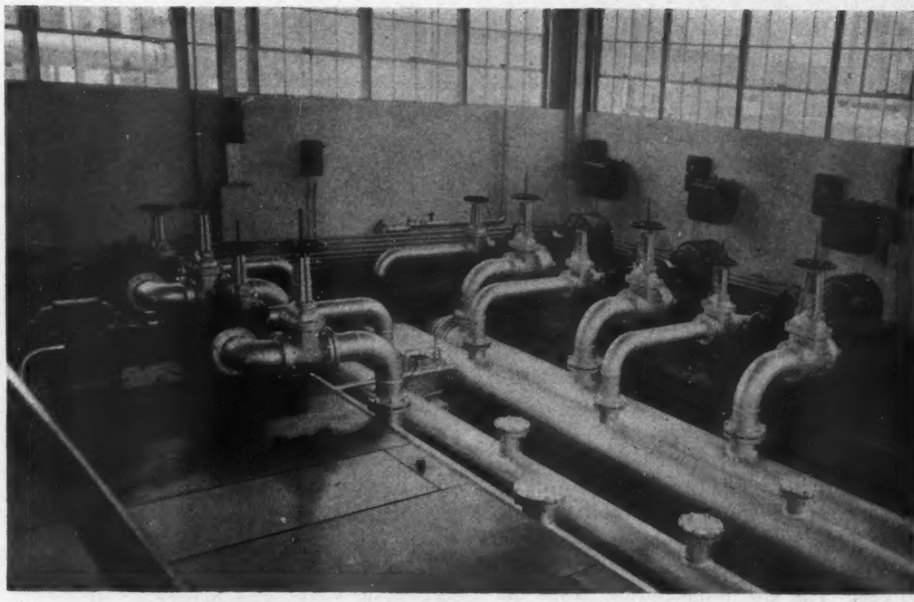
Last December the company placed in operation the twelfth compressor station, located in Hansford County, Texas. As reference to the map will show, it is on the 22-inch line that carries gas originating in the Amarillo Field from the Sneed to the Liberal Station, where it is joined by gas from the Hugoton Field. The site of the new station and the capacity and character of its equipment were determined by engineering studies in which careful consideration was given to existing and probable future demands for gas. It was decided that a plant handling 160,000,000 cubic feet of gas a day at 450 pounds discharge pressure would best meet the initial requirements.

The compressors selected for the Hansford Station differ in design from those in the other stations and from the machines heretofore generally used for main-line gas transmission. They are Ingersoll-Rand LVG units each consisting of a 650-hp., 300-rpm., vertical, V-type, 8-cylinder, 4-cycle, single-acting gas engine direct connected to two double-acting, single-stage, horizontal compression cylinders. Six of these units are installed, making a total of 3,900 hp. To enable the company to meet the increased demand expected in 1942, two more identical machines have been ordered. Upon their installation next summer, the compressor capacity of the station will be 5,200 hp. The compression cylinders of these units are designed to operate at a suction pressure of 275 to 325 pounds and a discharge pressure of 400 to 450 pounds. They are equipped with clearance pockets, valve lifters, and internally built by-passes. Because of these features, plus suitable controls on the engine governor, the engine speed can be varied anywhere within the range of full to half speed and the

compressor loads from full load to no load. This great flexibility is of particular advantage in the Hansford Station because it is primarily a booster on a section of the main transmission line in which the volume of gas delivered is subject to considerable fluctuation. Compressor cylinders are of such a diameter in relation to engine power that the engine will not be overloaded by more than 10 per cent of its rated horsepower under maximum loading conditions. This makes it possible to use the minimum number of compressors when loads are light and tends to balance load conditions over a year's operation. Indications are that only 65 to 75 per cent of the capacity of the Hansford Station will be required at present to handle the load in the summertime. Another advantage of the LVG is the reduction in floor space and foundation, as compared with the conventional twin-tandem horizontal unit. The LVG occupies only 14x17 feet of floor space, and its foundation contains 0.10 cubic yard of concrete per brake horsepower, as against 0.30 cubic yard for the horizontal machine.

The type of gas engine used to drive the compressors in the Hansford Station is not entirely new to the Panhandle system. The LVG compressor is the counterpart, on a larger scale, of the Type XVG that has been manufactured by Ingersoll-Rand Company since 1932. As the Type PVG, the engine end of the XVG has been offered during the intervening period for driving generators, pumps, line shafting, etc. In 1936, Panhandle installed in the Liberal Station two 370-hp., 8-cylinder PVG engines direct connected to 250-kw. generators, and added a third unit in 1940. Also, two 275-hp., 6-cylinder PVG's have been driving 200-kw. generators in the Tuscola, Ill., Station for several years. Panhandle engineers were therefore familiar with the design and construction features of the Type LVG machines when they specified them for main-line gas-transmission service at the Hansford Station.

Both the Sneed and Liberal stations contain equipment for dehydrating the gas that comes to them through their respective systems of field gathering lines. When gas is compressed to a high pressure, its water-vapor content tends to condense and to form a deposit on the interior walls of the line leading from the station. This is objectionable at all times and may have serious results in winter be-



PUMPS AT HANSFORD STATION

Cooling water at the Hansford Station is obtained from two wells, each 20 inches in diameter and 300 feet deep and having a capacity of 300 gpm. Because of the dusty atmosphere, a closed circulation system is used for cooling the engine and compressor cylinders, thereby keeping mud deposits out of the water jackets. This water is treated to soften it. Water warmed by passage through the machines is cooled in a shell-and-tube heat exchanger, its heat being transferred to raw water flowing through the tubes The raw water is cooled, in turn, by passing it over an atmospheric cooling tower. The water is handled by the five Ingersoll-Rand Class AFV centrifugal pumps shown here. Three of them are for raw water and two for treated water.

COMPRESSORS AT HANSFORD STATION

These six Ingersoll-Rand 650-hp., Type LVG gas-engine-driven compressors are arranged three in a line, with the units in the two lines back to back. Incoming gas enters the station through a 22-inch line that divides into two 16-inch underground headers extending one along each side of the building. From these headers an 8-inch line leads to a 12-inch intake header above each compressor. The same piping arrangement, in reverse order, handles discharged gas, the 16-inch headers extending to a cooling tower where the gas flows upward through six cooling sections before being delivered to the 22-inch transmission line leading to the Liberal Station.

cause of the formation of hydrates and consequent line freezes that cause excessive pressure drops with attendant curtailment or interruption in service. Drying the gas protects the pipe interior and joint couplings from corrosion, always insures full pipe-line-capacity delivery, and gives the gas a more uniform heating value.

At the Sneed Station the gas is dehydrated by bringing it in contact with diethylene glycol, a liquid that has a great affinity for water. This is done in vessels known as contactor-separators provided with a series of internal baffles. As the gas enters at the top the chemical is injected into it, and the stream then impinges against a convex head. This causes it to separate into dry gas and water-bearing glycol, accompanied by a small amount of gasoline that also has been extracted from the gas. The gas is discharged from the vessel and enters the main transmission line: the liquid drops to the bottom of the contactor-separator from which it is automatically drained and passed to another vessel in which the gasoline and other condensed hydrocarbons are separated from the water-glycol mixture. The latter is forced under about 15 pounds pressure through a 2-inch line leading to a rectifying column. On its way to this column the mixture is preheated in a bank of heat exchangers, the heat being obtained from the hot glycol coming from the rectifying column.

The warmed liquid enters the column at a point about halfway up, and then descends slowly over a series of bubble trays. From the bottom tray it is piped to a reboiler, in which it is heated to 270°F. and then forced back to the bottom of the column. Steam and glycol vapors released from the boiling liquid ascend the column from tray to tray through the bubble caps, and as the vapors meet the descending water-glycol mixture the glycol vapor has a tendency to join the down-flowing liquid and the water, in the form of steam, the up-flowing vapors, thus effecting a separation of the two. When the water-glycol solution first enters the tower, some of both of the liquids vaporizes and bubbles up through the upper trays. To prevent the glycol vapors from being carried off at the top with the steam, water is introduced into the top tray as a reflux to maintain a constant temperature differential between the top and bottom of the vessel. As the reflux descends the column its temperature increases and it further condenses or enriches the glycol vapors. In addition to dehydration equipment, the Liberal Station includes a gasoline-extraction plant that operates on the absorption principle. It has a capacity of 280,000,000 cubic feet of gas a day. The gas is comparatively lean, containing 400 gallons of gasoline per 1,000,000 cubic feet. The extracted gasoline is sold to the Phillips Petroleum Company.

At each compressor station there is a group of plant structures and at five of them are also houses for employees. The main compressor building is of structural steel, with corrugated asbestos siding and roofing. Exhaust mufflers on the compressors are cooled by air that circulates between them and an outer casing. In winter, this flow of air is induced by blowers with a capacity of 4,000 and 10,000 cfm. Their intakes are inside the building, and the air, after being warmed by the exhaust, is returned to it through ducts over the windows to heat the interior. In summer the blowers circulate outside air inside the building to cool it. At three western stations that are in the dust-bowl area the air is drawn through a spray chamber and mist extractor. Slight pressure is maintained inside the structures and effectually excludes dust carried by winds with a velocity up to 45 miles an hour. When the blowers serve for building-cooling purposes the mufflers are cooled by air drawn through their inclosing casings by the pull of the engine exhausts.

Water for station use is obtained from driven wells from 50 to 1,300 feet deep. They are usually located nearby; but in the case of one in Kansas the water has to be pumped 7 miles. Water for cooling the engine and compressor cylinders is softened in Permutit-zeolite systems. At every station except Hansford it is circulated in an open system and, after passing through the cylinder jackets, is cooled by pumping it over a Fluor aerator-type tower. At Hansford the treated water flows in a closed circuit. From the cylinder jackets it goes to coils in the cooling tower where it is cooled by raw water. At all stations, before the gas is sent out, the heat of compression is removed from it by passing it through coils in the base of the cooling tower. This is done to reduce its volume, to lessen expansion of the pipe line, and to minimize the effect of heat on the gaskets in the joint couplings.

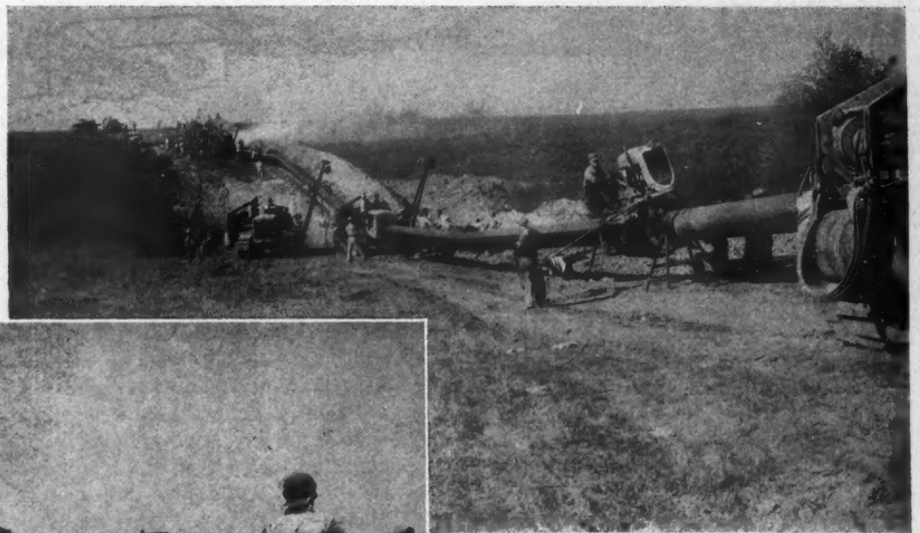
At alternate stations the gas passes through scrubbing towers to remove small particles of iron, sand, and other extraneous materials, in the form of dust, that are very abrasive to compressor valves, regulators, and meters. Every station has an auxiliary building in which are gas-engine-driven generators to supply electricity for power and lighting, a station for measuring the gas used by the main engines and auxiliaries, a garage and warehouse, and a superintendent's residence. The operating force on each shift usually consists of an engineer, an auxiliary engineer, an oiler for every two engines, and a varying number of laborers.

Throughout its length, the Panhandle pipe line lies at least 30 inches underground. The older parts of it are made up of 20-foot sections; but for several years past pipe has been delivered in 40-foot lengths. Two of these are welded together, and the 80-foot sections are connected with Dresser couplings. The newer pipe has a wall thickness of 9/32 inch. It is of seamless-steel or electric-weld construction, and the approximate weight per

COMPRESSOR STARTING UNITS

The gas engines that drive compressors and auxiliaries in the various stations are started with compressed air at 250 pounds pressure. Some of the air supply is reduced to 100 pounds pressure and distributed through service lines to operate drills, riveting hammers, and other tools. By making a further reduction to 15 pounds pressure, air is obtained for use in the displacement pumping of lubricating oil from outside storage tanks into the main building. In seven of the stations the air for these three services is furnished by Ingersoll-Rand compressors such as those shown here. At the left is a Type 30 air-cooled unit driven by a 15-hp. gas engine: at the right is an ES-2 machine, with automatic control, driven by V-belts from a 20-hp. motor.

Photos courtesy of
The Barrett Company



PIPE-LAYING OPERATIONS

Pipe lines are buried to avoid interfering with ordinary surface uses of the land, to keep the pipe at a fairly even temperature to reduce expansion, and for other reasons. Conventional ditching machines, supplemented by rock drills and dynamite in the occasional rocky stretches encountered, dig the trench. To protect it against corrosion, the pipe is cleaned and coated first with a coal-tar primer and then with a coal-tar enamel containing a flaky micaceous reinforcing material. Cleaning is done by the machine in the foreground of the upper picture. At its forward end is a revolving cleaning head containing some 125 small chisels: at the rear is equipment for applying the primer coat. The enamel also is applied mechanically (by hand in the winter), as shown in the lower picture. The pipe is next inspected electrically to make certain that it is amply protected, and is finally whitewashed to cut down absorption of the sun's rays and to reduce expansion. Pipe is laid in the cool of the morning, operations ordinarily being stopped by 10:30 during the summer. In favorable weather, 2 or 3 miles of line can be laid each day in the plains country.

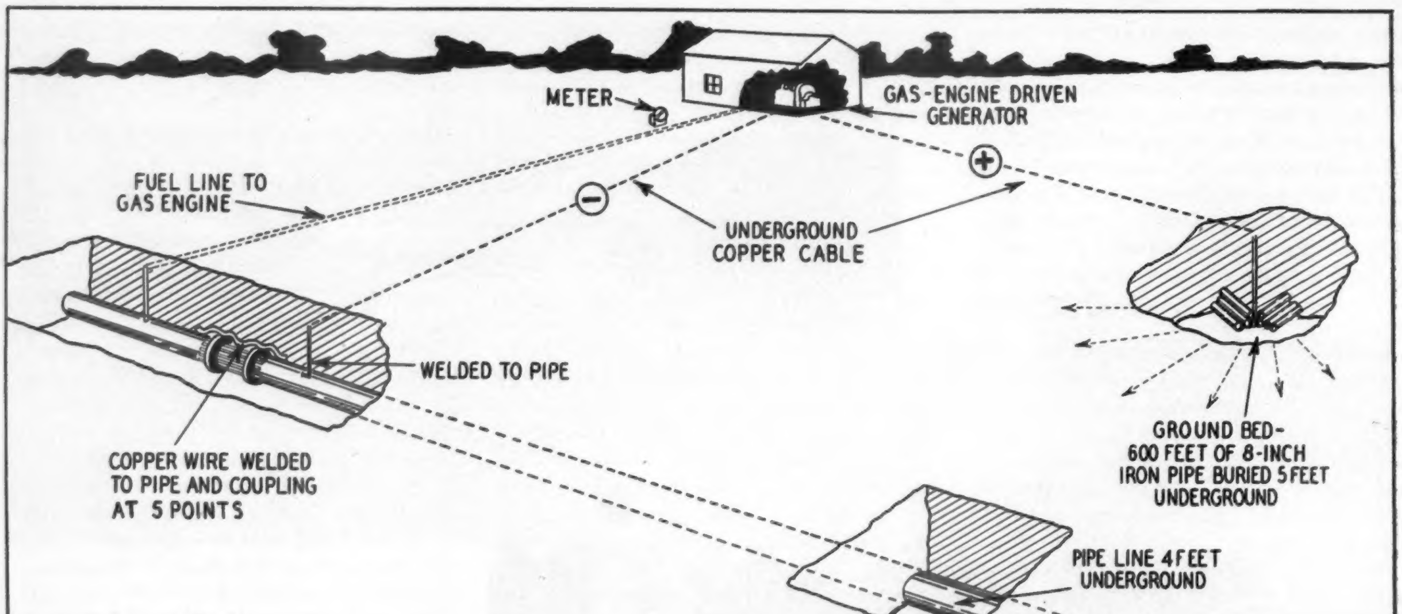
foot is 86 pounds for 22-inch and 94 pounds for 24-inch pipe. Wherever the line passes under a highway it is encased in a larger pipe, which is vented to the atmosphere by a 2-inch line. The crossing of the Mississippi River at Louisiana, Mo., consists of two submarine 12-inch lines and one 22-inch line that is carried on a highway bridge.

The main line is fitted with Venturi-type steel gate valves at 8-mile intervals, making it possible to close off any section between two valves when required. There is a 6-inch by-pass line around each valve and a 6-inch blow-off line on each side of every valve. These valve stations provide means for regularly cleaning the pipe by passing a go-devil through it. Carried through by the gas stream, the go-devil's revolving mechanical brushes dislodge rust from the walls and push it along, together with dust and sand that get into lines during construction. For best results the pipe must be clean and smooth inside. A 1/32-inch incrustation will occasionally reduce the capacity of a 24-inch line to that of a 20-inch line. The use of go-devils has increased the transmission efficiency of some sections of the Panhandle system from approximately 70 to more than 90 per cent.

The line is regularly patrolled by walkers whose duty it is to note the pressure, inspect regulators, and report leaks, road construction across the line, washouts, landslides, the dredging of streams, complaints of customers or land owners, etc. Stiles of 2-inch pipe are provided at fences for the use of these men. In the prairie country, where cattle are on the range, the patrolmen ride horses as a protection against attack by ill-tempered animals. The company has its own overhead telephone system that parallels the pipe line for 650 miles from Amarillo to Louisburg. There are drops at intervals of 8 miles, and the patrolmen carry field telephone sets which enable them to plug in at those points. There is a leased-wire connection between Louisburg and Kansas City, Mo., where the general offices are located. For operating purposes, the line is divided into an eastern and a western division.

Because more than 90 per cent of a gas-transmission company's property is underground where it cannot be seen, the task of protecting it from corrosion is a difficult one. Such protection is highly important, however, for several reasons, not the least of which is the fact that a line such as the one we are discussing costs around $30,000 a mile. The operating companies therefore make every effort to detect and check corrosion. All those of appreciable size maintain a special department to look after this work; and in recent years they have developed some interesting scientific methods of coping with the problem. Panhandle Eastern has been one of the leaders in this movement.

Once a year, a routine inspection of the line is made, and at locations where evidence points to possible corrosion, "bell holes" or pits are dug and the actual condition of the pipe is observed. In addition to this, a continual program of investigation is carried on and corrective measures are taken wherever they are required. It has been determined that external corrosion of a buried pipe line is generally caused by electrolytic action between the pipe and the surrounding soil. Whenever electric currents flow along a pipe and leave it, there will be pitting at the point of discharge. Before a pipe is buried it is covered with protective enamel which resists electric discharge, but breaks or holidays (spots on a painted surface accidentally left uncovered) in the coating, exposing the metal surface, are inevitable. The electric currents may have strayed to the pipe line from some outside source such as a traction line or pumping station, or they may have been generated by galvanic action between the pipe and the surrounding earth. That iron has an affinity for certain elements in the soil, and



PROTECTING LINE AGAINST CORROSION

As it has been determined that pitting occurs wherever there is an electrical discharge from a pipe line, engineers create a flow of current from the soil to the pipe to overcome this condition. From a direct-current generator the current flows through a cable to a ground bed of scrap pipe, from which it spreads out fanwise and travels through the earth to the pipe line. It follows along the latter to a cable connection that returns it to the negative side of the generator. Joint couplings are bridged with copper wire to provide an electrically continuous path.

that it has a tendency to replace those elements in combination with others, has been definitely established, together with the fact that each reaction is accompanied by a discharge of electricity from the corroding metal. It has been demonstrated that a chemical reaction may be started, stopped, or reversed by the proper application of electricity.

For a current to flow between two points there must be a difference in potential (voltage) between them. So-called hot spots or corrosion areas are consequently detected by taking pipe-to-soil potential readings. This is done with a sensitive millivoltmeter connected to two electrodes. The buried pipe is located with a probe bar, and when the latter is withdrawn, an iron rod is placed in the hole and a good contact established with the pipe. A wire connection is then made between the rod and the negative post of the meter. The second electrode is similarly connected with the positive post of the meter and inserted in a shallow hole directly over the pipe line.

If an ordinary iron rod were used to make contact with the soil, erroneous results would be obtained because of polarization of the rod—the collection of gases on the surface of any metallic electrode. The extent of the polarization will vary with the characteristics of the soil, the moisture content, and the depth to which the rod penetrates the ground. To eliminate this phenomenon, a nonpolarizing copper-sulphate electrode is used. The meter reading is then taken and a correction factor applied to compensate for the natural battery action that is set up between the copper-sulphate electrode and the steel pipe. This correction factor is taken to be 550 millivolts. For practical purposes, therefore, if the meter reading is more than 550 millivolts, it shows that the flow of current is from soil to pipe and that the pipe is adequately protected. Conversely, if the reading is less than 550 millivolts, the assumption is that current is leaving the pipe and that corrosion is taking place. These are not arbitrary decisions, though the influence of varying soil conditions often gives rise to erroneous conclusions. However, where there is reason to doubt that the indicated condition exists, a check can be made by digging a bell hole and examining the pipe.

Inasmuch as electrochemical corrosion cannot take place unless current is leaving the pipe line, the obvious method of coping with a hot spot or a series of them is to set up means for reversing the direction of the current flow, in other words to create a higher potential in the surrounding soil than exists in the pipe. This is just what is done; and it is accomplished by what is known as cathodic protection. The science of electrochemistry has given us the following three terms: anode, cathode, and electrolyte, all of which are parts of a simple galvanic cell. The anode is the electrode discharging ions into the electrolyte; the cathode is the electrode collecting ions from the electrolyte; and the electrolyte is the solution capable of conducting an electric current. In electrical-protection work relating to pipe lines, the pipe is made negative in the circuit so as to gather electricity and thus become the cathode, hence the term cathodic protection.

Cathodic protection operates on the same principle as electroplating. To refresh our memory of the latter process, let us assume that we desire to coat a spoon with silver. We immerse a bar of silver and a spoon in a bath of silver nitrate, which is the electrolyte or current-carrying medium. We connect the positive terminal of a battery of suitable power to the bar of silver, which becomes the positive electrode (anode). Then we connect the spoon, or negative electrode (cathode) to the negative post of the battery. With that done, silver from the bar will be carried through the solution and deposited on the spoon.

By cathodic protection the polarity of the pipe is reversed with reference to the soil. The pipe, or cathode, gathers ions or electricity, and the anode, placed at some remote point in the soil, discharges ions or electricity. This is accomplished by impressing a difference of potential (voltage) on the anode and the cathode. Current is caused to flow from the anode to the cathode, thus saving the cathode at the expense of the anode. The necessary current is either purchased from existing power sources in the vicinity, developed on the spot, or produced by a galvanic cell.

The means of generating direct current or of converting alternating current are generally known; but the galvanic cell is less familiar. In the latter case, the pipe line serves as the cathode, and some metal above iron in the electromotive-force series (chemically more active) is selected for the anode, which is also buried, but at some distance from the pipe line, the two being tied together to provide a return path for the current collected by the pipe.

Here, again, the cathode is preserved at the expense of the anode. Anode materials are generally classified according to the type of installation. Where current is bought or produced, they consist of carbon or scrap iron: if a galvanic cell is built they are pure zinc or magnesium.

An accompanying illustration shows a typical cathode-protection unit in which the current is generated. The negative side of a source of direct current is connected by cable with the pipe line. The positive side is similarly connected with a ground bed of scrap metal buried in the earth at a point 300 to 600 feet away from the pipe. The current flows to the ground bed, spreads through the soil, which serves as the electrolyte, and collects on the pipe. It then follows the pipe line to the negative connection, through which it returns to the generator, completing the circuit. Upon leaving the ground bed the current seeks the path of least resistance to the pipe; but the resistance offered by the ground causes it to spread out fanwise in several lines. After it has followed the latter for some distance it tends to turn away from them and to take direct courses to the pipe line. Sections up to four miles long are regularly protected in this manner.

Any one of three types of power units is used, the choice in each case depending upon the location. If it is accessible to electric lines, a rectifier of 12 volts and 50 amperes is employed to convert alternating into direct current. In areas remote from power lines, which includes the greater part of the Panhandle system, either a wind-driven or a gas-engine-driven generator is set up. The former is used along some of the western sections of the line where the wind blows with great regularity, and has a capacity of 20 volts and 80 amperes. Because gas from the pipe line is always available, 20-volt, 100-ampere gas-engine-driven units serve wherever conditions are unfavorable to either of the two other types.

It has been found that scrap pipe of 6- or 8-inch size makes a better ground bed than other scrap because it spreads the current out instead of concentrating it in a small area. Although there are several optional arrangements of the pipe, it is usually laid horizontally in the form of a "V" with a number of pipes in each branch. As the metal is destroyed at the rate of 20 pounds a year for each ampere of current used, or 2,000 pounds annually in the case of a 100-ampere unit, a considerable quantity is required. A typical ground bed consists of 600 feet of 8-inch pipe weighing 32 pounds per foot, or 19,200 pounds in all. It has been proved that there is less resistance to the spreading of the current if the ground bed is placed in clay soil containing considerable moisture, and such a location is therefore sought. As salts and ample moisture decrease resistance, both are added. As much as 2,000 pounds of common rock salt is often mixed with the earth removed from a ground-bed trench before it is replaced, and water is poured in during backfilling. The cable connections are usually buried to prevent theft of the copper. Because the size of the ground bed and the capacity of the unit have a bearing on the extent to which the current will spread, they are varied at each location to meet prevailing conditions. Experience guides the crews in determining them so as to provide the necessary coverage for the pipe line.

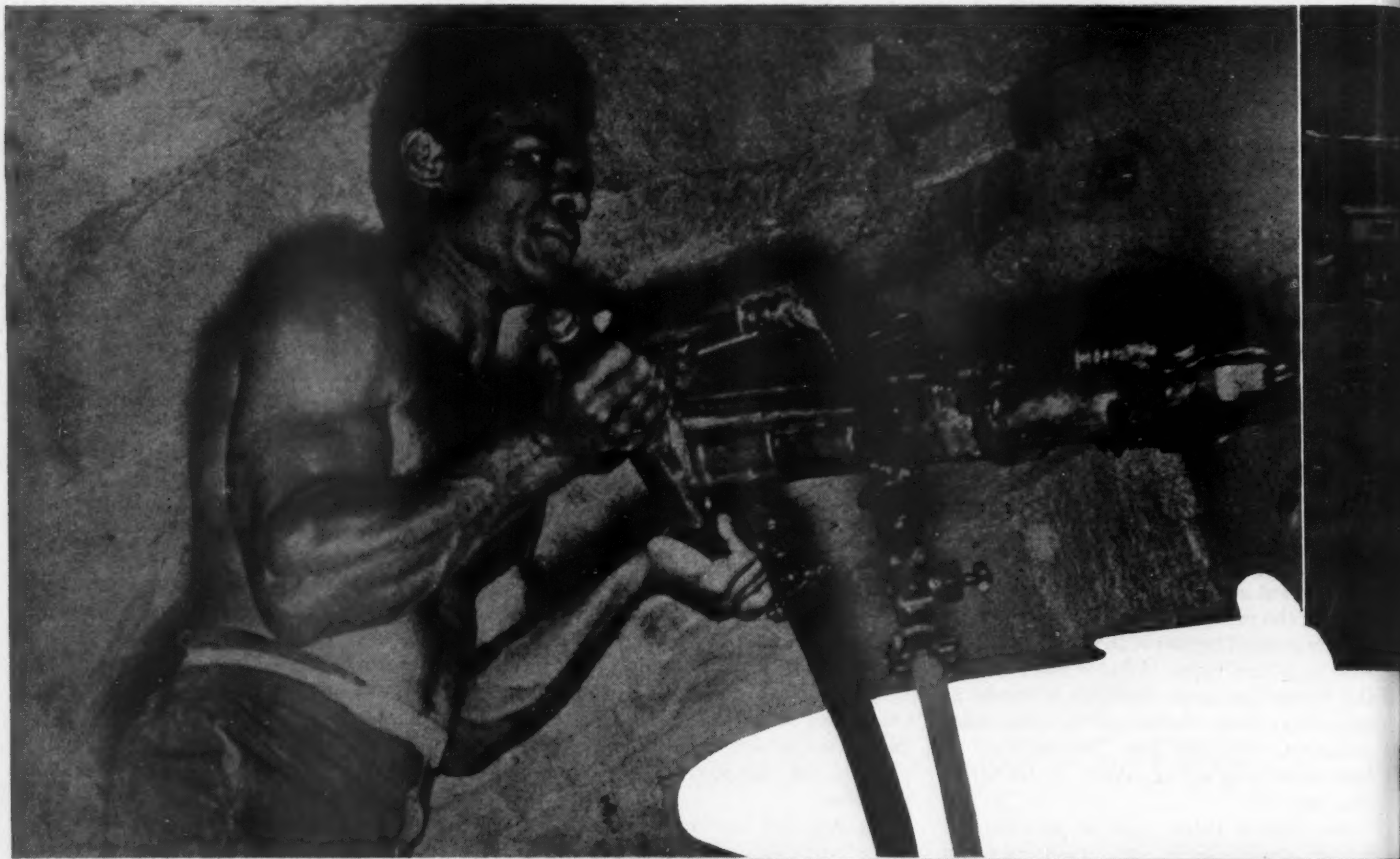
Because the current reaching the pipe line at different points must travel along the pipe to the negative connection it is essential that an electrically continuous path be provided for it. To accomplish this, adjoining lengths of pipe are bonded with a piece of copper wire that bridges the coupling. As corrosion also affects the coupling, it is desirable to protect it as well as the pipe. This is done by bending the copper wire so that it touches the center of the coupling and the follower rings on each side of it. The wire is spot-welded at these points and also where it comes in contact with the pipe on both sides of the coupling.

As the nature of the soil in which a pipe line is buried has a direct bearing on the incidence of corrosion, soil study is an integral part of the program of protection. Panhandle engineers have taken a pint sample of soil at intervals of 500 feet all along the line from its western end to the Indiana border. These specimens, some 11,000 in number, are kept in the laboratory at Kansas City for reference and are tested to determine their pH value (acidity or alkalinity) and their electrical resistance, the data being put in files. Information concerning the corrosion characteristics of the soil is obtained by subjecting one cubic centimeter to 500 pounds pressure and passing current at 1.4 volts through it while resting between two plates of pipe steel. From the results observed it is possible, with the aid of tables, to predict the theoretical life of bare pipe in that particular kind of earth. Where the conditions are such as to indicate that the pipe will last less than ten years, sections of the line in the area from which the sample came are uncovered for inspection. It is interesting to note that in all such cases so far investigated the pipe has been found to be pitted.

In the foregoing pages it has been possible to mention only a few of the many problems that must be coped with in operating a pipe line of the magnitude described to insure its customers continuous service. It goes without saying that any interruption in the supply of gas would be costly to industrial consumers and very annoying to domestic users. To guard against such occurrences, the Panhandle Eastern Pipe Line Company has made it a policy to use the best and most reliable equipment available and never to relax its vigilance over every part of its extensive pipe-line system.

SOIL-TESTING WORK

A sample of earth has been taken at intervals of 500 feet along the pipe line all the way from Texas to the Indiana state line. A 2-ounce portion of each sample is kept in the laboratory at Kansas City as a permanent record (above). The picture at the left shows a soil-testing crew in the field.



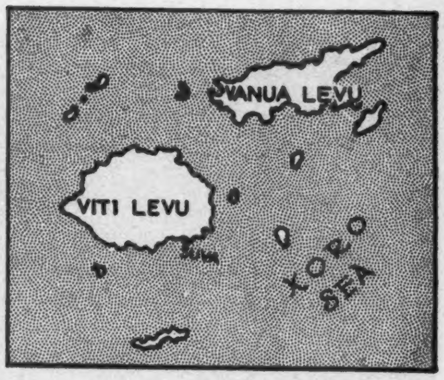
ALTHOUGH gold was first found in the Fiji Islands more than 70 years ago, the gold-mining industry there is less than ten years old, the intervening six decades having failed to bring to light deposits of workable character. The initial strike was reported from the district of Navua in 1868, and was followed by one from Kadavu in 1874. Six years later a European named Dods made the discovery in Yanawai that probably led to the find by Sesselman in 1895 that brought about the development of the Mt. Kasi Mine on Vanua Levu (Big Land) Island.

The first strike at Tavua, the present major producing area on Viti Levu Island, was made by a Frenchman, B. A. de Este. He came into a legacy shortly afterward and returned to his native land without disclosing its location. On November 4, 1932, a prospector named Bill Borthwick, who was backed by Pat. Costello of Suva, made a rich discovery there that precipitated a rush in which the land was pegged for miles around. It was not until two years later, however, that the real worth of the deposits was realized. The section is known as the Vatukoula Field, and is the scene of operations of the two largest Fiji producers, Loloma Gold Mines and Emperor Gold Mining Company, Ltd. It is with these that this article largely deals. Both are operated by the Associated Companies, of which E. G. Theodore is managing director.

The site of the Emperor property was optioned to Mr. Theodore in October, 1933. The claims were taken over later, and the Emperor company was formed in September, 1934, with a capitalization of 100,000 Australian pounds. Under the terms of the option the prospectors were paid 10,000 pounds and allotted 15,000 shares of stock, with Mr. Theodore and his associates holding the remaining interest. A plant to mine and mill 300 tons of ore monthly was initially set up, and by the time production began a sum of 40,000 pounds had been expended. By June, 1935, the developments were such as to warrant increasing the facilities, and this was done by Emperor Mines, Ltd., a holding company that absorbed all the assets and properties of its predecessor. It is capitalized at 1,000,000 pounds.

What is now the Loloma Mine was also discovered in 1932. The claim was originally owned by a hotel keeper, who sold it in 1933 to W. Lawler for 25 pounds. Lawler interested a Melbourne syndicate in the property and continued prospecting it for the group. These efforts failed to reveal commercial deposits, and Lawler's backers became discouraged and made him a present of the ground. Soon afterward he made a promising discovery and sold an option to purchase the land to Mr.

*Formerly Assistant Mine Superintendent and Surveyor, Loloma Gold Mines, N. L., Fiji Islands.



IN THE VATUKOULA GOLD FIELD

The panel is a panorama of the Vatukoula Field from which comes most of Fiji's gold. It is located in the northern part of Viti Levu Island, largest of the Fiji group, which is approximately 1,100 miles north of New Zealand. Gold is also found on Vanua Levu Island, where the principal producer is the Mt. Kasi Mine. In the Vatukoula Field the two major producers, employing more than 1,700 men, are the Emperor and Loloma mines, both operated by the Associated Companies. A key to the numbers on the general view follows: 1-General offices; 2-Loloma Mill; 3-Emperor Mill; 4-Powerhouse; 5-Theodore Shaft; 6-Wallace Smith Shaft; 7-Slimes dams; 8-Fijian married quarters; 9-Fijian single quarters; 10-European married quarters; 11-Sawmill; 12-Explosives magazines; 13-Euronesian married quarters; 14-Fitting shop and store; 15-Seacoast. A Fijian driller in the Loloma Mine is shown at the top left. Above, at the left, is a view of the Loloma Mill, with the main conveyor from the Theodore Shaft under construction.

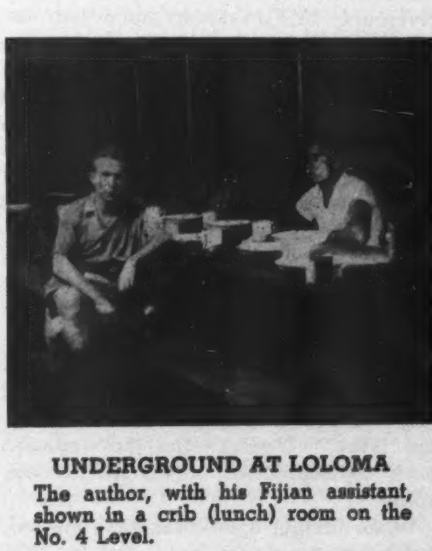
Fiji Gold

*John Cramer-Roberts**

Theodore for 1,000 pounds. The option was exercised in May, 1935, the terms providing that Lawler was to receive 10,000 pounds in cash and a 15 per cent interest in the company that was to be formed. In the following August, Loloma Gold Mines was organized with a capitalization of 225,000 Australian pounds. Its mill began operating in September, 1937.

During the years 1935 to 1940, inclusive, the Emperor Mine produced and milled 559,634 tons of ore, from which was extracted 186,323 ounces of fine gold. This, together with the accompanying silver, had a gross value of 1,605,961 Australian pounds ($5,187,254 at current rate of exchange). From September, 1937, when its mill began crushing ore, until the end of 1940, Loloma produced and treated 93,413 tons of ore and recovered 129,541 ounces of fine gold. The value of the gold and silver output was 1,146,149 Australian pounds ($3,702,061). The aggregate yield of the two properties was worth $8,889,315. Emperor ore had an average value per ton of $9.27, while Loloma's output showed the impressive average of nearly $40 a ton. Emperor is now operating at the rate of approximately 2,875 tons a week, and Loloma at the rate of 600 tons. Up to December, 1940, Loloma has paid eleven dividends and three bonuses, totaling 13 shillings ($2.08) per share, and Emperor has distributed payments of 5 shillings, 6 pence (88 cents) per share.

The Vatukoula gold field lies in a basin of undulating surface having mountains that rise to a height of 1,200 feet on three sides of it. To the north and 6 miles away is the seacoast. The lodes, which are of the fissure type, run in a northwest-southeast direction. The Loloma lode has been traced on the surface for more that 2,000 feet and has been proved to be payable for 1,500 feet. The main vein and other proved parallel veins are inclosed by walls of basalt, and in a number of instances flat "makes," disposed horizontally to slightly inclined bodies of volcanic ash, are found on both sides of the main fissure. Some of these are rich in mineral and add considerably to the yield. The Emperor lode is east of the Loloma vein and parallel to it. It also is of the fissure type, but extensive faulting has occurred and there has been enrichment of the country rock through the numerous bedding planes of the main breach. In addition to basalts, much of the country rock is made up of andesite. It is possible that the ash associated with the flat makes are decomposed andesite, but the prevailing opinion is that it came from volcanic eruptions and flows. The gold occurs as tellurides, principally as sylvanite, although krennerite and nagyagite also are found. Silver likewise is present in combination with telluride. Other metals are iron and copper (as pyrites and chalcopyrite), antimony (as the sulphide stibnite), and native tellurium



UNDERGROUND AT LOLOMA

The author, with his Fijian assistant, shown in a crib (lunch) room on the No. 4 Level.

EMPEROR OPEN CUT

At the left is a view from the south. The powerhouse is on top of the bank at the right. The picture below shows a power shovel loading a truck.

Both the Emperor and Loloma deposits were opened through surface cuts. The former is still worked almost entirely in that way, and from 1 to 1.8 tons of overburden is handled for each ton of ore. As depth is gained, some suitable system of underground mining will have to be adopted. The Loloma method of mining is primarily cut-and-fill, although rill stoping also is being successfully practiced. On the upper levels, extensive timbering is necessary because of friable walls and water oozing from the overhead rock.

In open-cut work the overburden is first stripped away, and then the exposed mineral is mined. Both materials are loaded by three Ruston-Bucyrus 21-B electric shovels into ten 3-ton hydraulic-dumping Ford trucks and two Athey cars drawn by Caterpillar diesel tractors. Owing to the topography, the waste material is all utilized in creating building sites and in constructing roads. Later it may find application in filling underground stopes.

Development headings are in most cases driven under contracts, which are given only to Euronesian and Fijian employees. If the ground is safe, the heading is at first advanced without timbering. After a main section has been completed it is timbered and put in order for use as a haulageway. Loading and underground haulage are now done manually, cars of 11-14 cubic-foot capacity being pushed along 15-inch-gauge track. Tracks of 24-inch gauge are soon to be installed to accommodate larger cars, and when these go into service loading will be done with air-operated mechanical units. The Loloma and Emperor mines are now connected underground; and, with increasing depth, they will probably have a common haulage level. Underground development work to September, 1940, totaled 8½ miles.

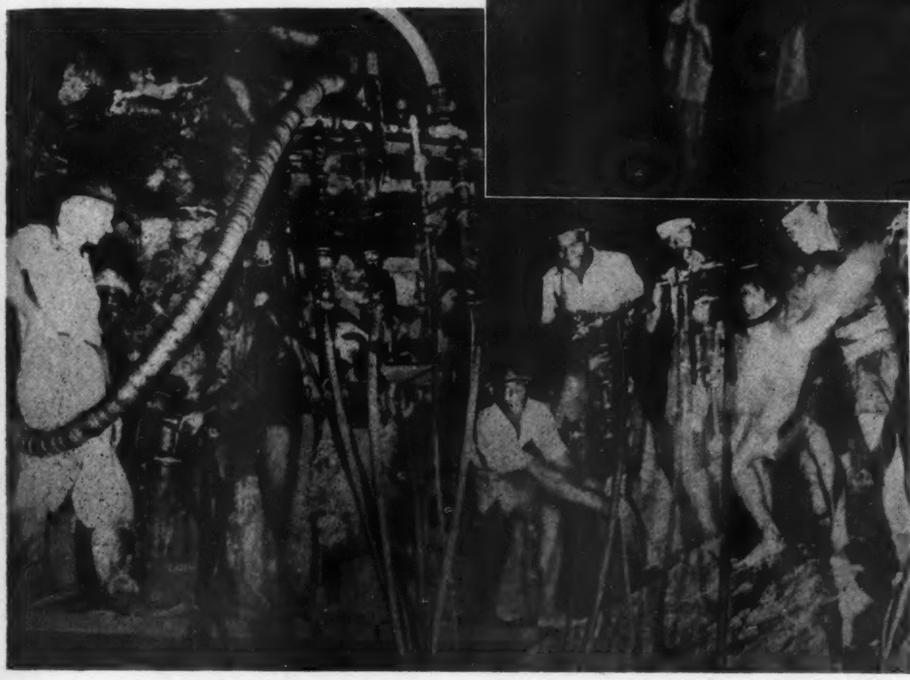
When mining operations were started, drilling was done by hand, but by 1935 mechanical drills had been adopted. Various types were employed in the beginning; but as soon as the worth of the field was established, standardization of equipment was undertaken. For normal drifting and stoping, Ingersoll-Rand JA-45 Jackhamers are used. Considering that the Fijian laborer has a lot to learn about drilling, the machines have given a fine account of themselves. The cost of underground work with these drills, including repairs and maintenance, ranges from 32 to 45 pence (a pence is normally equivalent to approximately two cents, United States currency) per foot. A heavier Jackhamer—the JA-55—is utilized for shaft sinking, and has likewise given good results. Short raises are sometimes driven with JA-45's, but usually with SAR-85 Stopehamers and JA-45 Jackhamers. In all cases air-line lubricators are used.

Open-cut drilling is done with Jackhamers and also with two churn drills. The latter machines are also employed for prospecting, especially of flat makes. Sludge samples for assaying and chip samples for geological examination are taken every 5 feet. Churn-drill holes are often bored for ventilation, for housing air lines and cables, and for other purposes. The greatest depth of hole so far drilled is 600 feet. The average cost per foot ranges from 3 to 5 shillings (48 to 80 cents). Diamond drills are utilized for prospecting from the surface as well as from underground locations where this method is used to search for parallel lodes. The average cost is around 8 shillings ($1.28) per foot. Maintenance and repair of drills and reconditioning of steel are carried out in a central shop. Drill-steel bits are resharpened by hot milling. Blasting is done with Nobel explosives. Gelignite of 40 and 50 per cent strengths and in cartridges of ⅞- and 1⅛-inch sizes serves in holes put in with air drills. The churn-drill holes are loaded with Monobel ranging in size up to 4 inches.

All shafts have balanced cages operated by electric drum hoists. Shaft timbering has been standardized wherever possible to permit interchanging cages and, later, the replacement of skips. The best obtainable Oregon timber is used, the vertical members consisting of sawed 8x8 or 10x10-inch sections. During shaft sinking the muck is hoisted in a scoop and dumped directly into trucks, the scoop being handled by a remote-controlled Ingersoll-Rand Size HU air hoist. Similar units are also employed for winzing purposes.

FIJIAN MINERS

Below is a shaft-sinking crew with JA-55 Jackhamers in the Loloma Mine. In the center is a cluster of air lines taking off from a manifold. Interposed in each is an air-line lubricator. The other picture shows a group of Fijian miners above ground.



So far the mines fortunately have not had to cope with much water. That which is present is collected in sumps at various levels and is pumped from them to the surface. During shaft-sinking operations an Ingersoll-Rand Size 25-T tandem sump pump is used. When supplied with air at 75 pounds pressure the latter will lift a 2-inch column of water 130 feet with ease. By slightly aerating a full 2½-inch column at a point just above the pump, the same unit has successfully operated against 150 feet of head in the Theodore Shaft of Loloma Mine.

As has already been indicated, the ore is a sulpho-telluride and is highly refractory. Loloma ore is crushed and roasted and then treated by cyanidation and flotation. In 1940, a recovery of 95.7 per cent of the contained values was achieved. The mill heads averaged 1.522 ounces in gold (worth $53.27 at $35 an ounce) per ton which, it is believed, rates them very high, if not first, among the world's gold mines. Emperor ore is not roasted, and the treatment varies from time to time to meet changes in the character of the ore. The original practice called for cyanidation before flotation, but this order is now reversed. Because there is no roasting, cyanide consumption is higher than for Loloma ore and the percentage of extraction is lower. Mill heads averaged 0.345 ounce ($12.07) per ton for 1939-40, and milling costs were approximately $1.57 a ton. Metallurgical investigations, looking towards the improvement of the processes employed, are carried on continually in well-equipped laboratories.

In addition to its own ore, the Emperor Mill handles approximately 2,000 tons a month from the Dolphin Mine of Fiji Mines Development, Ltd., which is owned by a small syndicate made up of Mr. Theodore and associates and is operated by the Associated Companies. This property is in reality another Loloma Mine on a smaller scale, and is located about half a mile from the latter property. The ore occurs in a fissure-type lode that is narrower and steeper and has a less altered wall structure than the others. Because of these conditions it can be mined by underhand stoping methods. The ore sent to the Emperor Mill averages 0.75 ounce ($26.25) in gold per ton.

A breakdown of the costs of producing and treating a ton of ore at the Emperor and Loloma properties for the fiscal year of 1939-40, with the figures converted into U. S. currency at the prevailing rate of exchange, follows:

Charge	Emperor	Loloma
Mining	$0.81	$2.34
Milling	1.56	4.23
General Expenses	0.43	1.81
Development	1.02	3.04
Royalty and Realization	0.74	3.38
Totals	$4.56	$14.80

These costs do not include London and Melbourne office expenses or provisions for depreciation and income taxes.

Salaries and wages during the year aggregated $569,074. Direct taxes, duty on direct imports, port and service taxes, royalty on gold produced, and income taxes totaling $366,876 were paid to the Fiji Government during the year, as compared with $218,751 the previous year. Indirect importations, made through Fiji firms, amounted to $500,863 in 1940, and the duty and taxes on them are not included in the foregoing figures. Capital expenditures in 1940 were $432,933, and for the two preceding years they amounted to $568,660.

Soon after the two companies began operating it was realized that a common power supply would be desirable from an economic standpoint, and the Tavua Power Proprietary, Ltd., was formed. Emperor owns two-thirds and Loloma one-third of it. As Fiji lacks coal deposits and streams capable of hydroelectric development, power is generated with diesel-engine units. The power house, which is located about 600 feet from the Emperor Mill, has a steel skeleton covered with asbestos-composition sheeting. It has a floor area of 128x48 feet, with a 14-foot-wide switchgear annex running along one side. The main structure is now being extended 68 feet to accommodate more equipment. This station supplies electricity, water, and compressed air to the entire field. It now contains four 770-hp. engines, each driving a 525-kw. generator, and air compressors having an aggregate capacity of 3,120 cfm. The engines are

NATIVE TYPES

The milk of green cocoanuts is a refreshing drink and a Fijian thinks nothing of climbing a 70-foot tree to get it (below). Native police guarding a gold shipment are shown at the right. The Fijian in the circle is preparing to roast a bullock's head. He first builds a fire of cocoanut fiber and heats a bed of stones. The head is placed on these and covered, in turn, with leaves, sacking, and earth. After twelve hours, it is ready to be eaten. Two native laborers of different statures are pictured at the far right. The trio in collegiate attire are surveyor's assistants about to start on a prospecting trip.

all of the 4-stroke-cycle, single-acting type, with uniform 15½x18-inch interchangeable cylinders. The generator engines are 7-cylinder units and run at 375 rpm., while the compressor engines with five cylinders operate at 300 rpm. All engine intakes are fitted with cocoanut-matting air filters which have proved very satisfactory.

Water is obtained from the Nasivi River half a mile away. Three 5-stage centrifugal pumps, each capable of handling 250 gpm. against a head of 460 feet, pump the water to three 20,000-gallon tanks. From these it flows by gravity to every part of the field where it supplies all mining, milling, and domestic needs except that of drinking water, which is obtained from rainfall.

In 1940, the employees of the Associated Companies numbered 1,715, and of these 123 were Europeans, 258 were Euronesians (half-castes or European-Fijians, European-Samoans, etc.), and 1,334 were Fijians and Indians. The latter are hired only for painting and truck driving. In all cases Europeans supervise the work done by others. It has not been easy to establish a native wage scale for the reason that the Fijian is not compelled to work and can only be encouraged to do so. Provided he remains in his own village or *koro* throughout the year, his government tax ranges from 1 pound, 10 shillings to 2 pounds, 10 shillings ($4.83 to $8.06 at the current rate of Australian exchange). If he absents himself he incurs an additional or absentee tax of 1 pound ($3.23). By remaining at home he can, with little effort, meet his tax by producing the native foodstuffs that grow so prolifically on the islands. Consequently, in order to get the natives to work in the mines, it was necessary from the beginning to offer them higher wages than are ordinarily paid in most parts of the world for colored labor. Surface workers, such as grass cutters, road laborers, and pick-and-shovel men, get 2 shillings (32 cents) a day. For each complete week of service they receive a bonus of 2 shillings. Starting wages for mill or underground laborers are 2 shillings, 6 pence (40 cents) per shift. At the end of six months, each worker is entitled to a raise of 6 pence (8 cents) per shift if his Euronesian and European superiors recommend it. Occasionally, surface workers obtain further increases, bringing the total per shift to 3 shillings, 4 pence (53 cents) or, if they are boss boys, to 3 shillings, 10 pence (61 cents). Mill and underground laborers get a second 6 pence raise after completing a year of service, if it is recommended. If their work continues to be satisfactory, the rate mounts to 3 shillings, 10 pence, except in the case of head boys, when it reaches 4 shillings, 4 pence (69 cents). Fijian tradesmen, such as carpenters, fitters, timbermen, and office clerks, come under a different schedule and are paid from 5 to 12 shillings (80 cents to $1.92) a day.

All Fijian employees are provided with rations and housing. An individual weekly ration consists of 3½ pounds of meat or fish, 3½ loaves of bread, ¼ pound of tea, ¼ pound of salt, 3 pounds of sugar, 7 pounds of rice, 4 ounces of soap, and 2 ounces of native tobacco. Some of the rice is replaced with native foodstuffs whenever they are obtainable. A further half-ration is supplied to married natives. Afternoon- and night-shift men are also given bread, jam, and tea while at work.

Euronesians are employed in all departments as subsidiary bosses, and many of them serve as carpenters, fitters, and hoist operators. They are paid from 6 shillings to 13 shillings, 4 pence (96 cents to $2.13) a day. They receive no rations, but get their lodgings—married ones being provided with houses. European employees are paid the equivalent of the sum earned by those doing similar work in Australia. They live rent free in furnished houses which vary in type with their status.

Recreation facilities are provided mainly through a "tobacco fund." Under the terms of leases granted to private merchants operating in the field, the sale of tobacco is reserved for the companies' store, and all profits are turned over to a committee that makes grants to the committees in charge of the various sports conducted by the Vatukoula Sports Association. These include cricket, rugby, soccer, hockey, and other games. In addi-

tion, there is a golf club with a 9-hole course, a tennis club, and a newly formed bowling club. A boxing stadium is under construction, and consideration is being given to a swimming pool.

A company store handles all materials needed in the field. Goods landed at the Port of Lautoka are hauled by contractors or in company-owned trucks over 60 miles of good roads. A newly constructed wharf only 17 miles distant will reduce transportation costs and expedite deliveries. Fuel oil from the United States and Borneo, and timber from British Columbia have already been landed at the new base, bulk oil being pumped into a 3,800-ton tank provided there. Aside from these commodities and heavy machinery, which comes mainly from Great Britain, most of the supplies are imported from Australia. Owing to the world situation, large stocks are carried—stores on hand at the time this article was written being valued at 120,000 pounds. They included more than 1,000,000 board feet of Douglas fir timber.

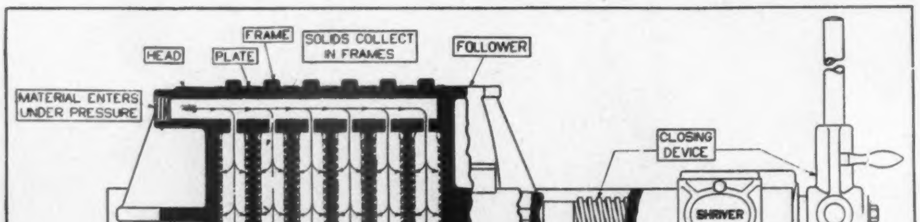
As of September, 1940, sufficient ore has been developed in the Emperor and Loloma mines for six years of production at the current rates; and encouraging results of exploratory work indicate that this period of operation will probably be materially lengthened. In addition to the Associated Companies properties, Aloha Central Mine in the Vatukoula Field has an output of from 50 to 80 ounces of gold monthly and good prospects for a long life. The principal producer on Vanua Levu Island, northeast of Viti Levu, is Mt. Kasi Mines, Ltd., which was organized in 1930. From open cuts and shrinkage stopes is obtained annually some 43,000 tons of ore having an average value of approximately $7.80 per ton.

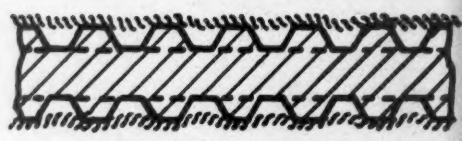
N. E. Nilsen is general manager of the Associated Companies and assumes full responsibility when Managing Director Theodore is absent. F. G. Potter is chief engineer, S. J. Coggins is secretary, T. Tavener is chief accountant, F. A. Campbell is mine geologist, and J. A. Allan is chief storekeeper. G. L. Ditchburn is assistant general manager and superintendent of the Emperor Mill, D. T. Mitchell is superintendent of the mine. For Loloma, A. R. Reed is mine superintendent and J. G. Bremner is mill superintendent. A. Grainger is superintendent of the Dolphin Mine. R. P. Kay is general manager of the subsidiary company, Tavua Power Proprietary, Ltd.

The writer gratefully acknowledges the help given him by the department heads and expresses thanks to Mr. Theodore for reviewing the manuscript and offering helpful criticism.

Control of Cupola Air Improves Filter Press Castings

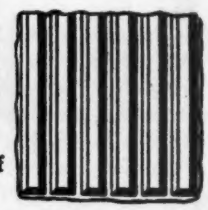
W. H. O'Connell





Cloth on pyramid surface

Pyramid surface of plate



Corrugated surface of plate

FILTER PRESS AND SECTION

The top view shows a typical Shriver filter press, with a frame and plate and an empty frame at its side. The principle of operation of a corner-feed press is illustrated just above. Scores of processing industries make use of this type, which varies in size and design to meet requirements. For most services filter plates are made with a pyramidal pattern because it supports the cloth well, provides a maximum of filtering surface, and permits adequate flow of the filtrate behind the cloth. In some instances a corrugated plate surface is supplied. Both are shown at the right.

FILTER presses are relied upon by thousands of process industries to separate solid matter from liquids. Sometimes they are employed as a means of clarifying a liquid, the solid content of which is worthless; in other cases the solids are recovered in cake form and the liquid is run to waste; and in still others, both the cake and the filtrate are of value. So wide are the uses and so indispensable is the service performed by filter presses that it is almost impossible today to eat a meal or to wear an oufit of clothes that does not embody something that has gone through a filter press.

Filter presses are not to be confused with vacuum filters, for each has its own particular field of usefulness. Here we are concerned only with filter presses. The simplest type is the household straining cloth such as is used in making fruit jelly. The liquid with the suspended solids is put in a cloth bag and pressure is exerted by squeezing or twisting it, thus forcing the liquid or filtrate out of the bag while the solid matter or filter cake remains inside. Commercial filter presses work on the same principle but on a large scale. They consist of a number of filter chambers of cloth-covered plates which are held tight together while the unit is in operation but which can be quickly dismantled to remove the filter cake.

Unlike the jelly-bag strainer, the filter press is continuously supplied with liquid under pressure and will function satisfactorily until the filter-cake chambers are full, at which time it must be shut down for cleaning. The rate of filtration depends upon the pressure of the incoming liquid, the thickness of the cake formed behind the filter cloth, the temperature and viscosity of the liquid, and the nature of the solids in the cake.

A filter press with side rails on which plates are assembled and with a heavy screw or piston arrangement to clamp the plates firmly together appears, at first sight, to be a device for squeezing liquid out of more or less solid material. But, as explained in the foregoing, this is not the case, although machines for extracting liquid from solid matter by mechanical pressure are employed in certain processes. Literally hundreds of styles of filter chambers have been devised, for the manifold filtering processes involve many

different operating problems. Except for such variations as alternate spacing frames to provide more room for filter cake, numerous arrangements for introducing the liquid and collecting the filtrate, and many different filter-plate face patterns, the basic features of the partition plates and cloth filters employed remain virtually the same.

For more than 40 years, T. Shriver & Company of Harrison, N. J., has been building filter presses of the type described. Its products are known throughout the world; and its laboratory and research department are continually on the lookout for new fields of application and designing equipment to meet those requirements. Sanitation, contamination, and corrosion, all must be considered in selecting the materials that enter into the construction of a filter press, yet for most services cast-iron plates and frames are satisfactory. It follows, then, that the company's gray-iron foundry accounts for a goodly percentage of the plant's activities. The plate castings made range in weight from 6 pounds for laboratory filter presses to 1,000 pounds for units used by the mining industry in ore-recovery plants. Cast-iron headpieces for the latter, weighing 6,000 pounds, are the largest castings made in the foundry. The company has estimated that the average plate produced by it weighs in the neighborhood of 300 pounds and has a web thickness of ⅜ inch.

Because the partition plates must be handled frequently when a filter press is in service, they are manufactured to combine light weight with strength so as to withstand the thrust of the liquid pumped in under pressure. This means thin wall sections which, in turn, call for careful foundry operations. The foundry's two No. 5 Whiting cupolas have a diameter of 52 inches inside the firebrick lining, giving each a capacity of about 9 tons per hour. In a normal day approximately 24 tons of iron are poured, requiring nearly three hours' melting time per cupola.

For many years the blast air for the cupolas was supplied by a positive displacement blower that was manually controlled by the cupola foreman. Years of practical operating experience have given foundrymen some rule-of-thumb methods of regulating the air blast. More or less dense air means more or less oxygen avail-

THE BLOWER
The blower that supplies air to the cupolas is inclosed in a brick structure to keep out foundry dust. The discharge line is shown in the foreground of the upper picture. The other view shows the intake side of the blower at close range. The discharge is at the bottom, and behind it, at the lower right, is visible the top of the motor that controls the blast gate so as to assure the delivery of a constant weight of air.

INTAKE FILTER

In order to obtain clean air for the cupola blower, an intake duct is extended to the roof and is fitted with the twin-element Coppus filter shown here.

able for combustion in each cubic foot of air passing through the blower to the cupola, and it is therefore essential, in order to assure consistently hot iron, that the blast compensate for changing atmospheric conditions.

For several years the operators of the Shriver foundry have realized that equipment that would make these adjustments automatically would help to improve the quality of the melt and, incidentally, the company's product. Investigation of the available equipment led to the selection of a 40-hp. Ingersoll-Rand Type FS Motorblower with an all-electric, constant-air-weight control mechanism that was developed in conjunction with the power characteristics of this line of centrifugal blowers. By means of it the blast gate of the blower is regulated so that the actual weight of air delivered per minute is held constant, irrespective of atmospheric changes. The installation is a model one, for every step has been taken to provide the most favorable operating conditions. At best, the air in a foundry is unavoidably dusty, so it was decided to place the new unit in what amounts to an airtight housing on the foundry floor and adjacent to the cupolas. From this room an air duct leads to a twin-element Coppus air filter on the foundry roof, thus supplying the blower clean air at all times.

From the start of operations, the management has been enthusiastic about the results obtained. In addition to affording complete independence of weather conditions, two other cupola-blowing uncertainties have been overcome. The first of these is attributable to the plugging or bridging which occasionally occurs in a cupola during the settling of the burning coke and melting iron. This temporarily builds up increasing resistance to the flow of blast air. Without automatic control, a constant-pressure centrifugal blower delivers a reduced volume of air, and the rate at which melting takes place consequently drops: with automatic control the motorized blast gate swings open, thus not only lowering the total resistance offered by the blast gate, piping, and cupola but also keeping it constant. Under these conditions there is no reduction in blast air, and the melting rate remains constant. When the coke in the "packed" area burns away and the bridging falls, the lowered resistance momentarily allows more air to pass, but the automatic control promptly steps in and closes the blast gate enough to bring the resistance and the rate of air delivery back to normal.

Towards the end of the melt, when no more coke and iron are added, the charge is allowed to burn down. As the remaining iron melts and the coke is consumed, the resistance to the flow of air naturally decreases and more and more air flows through the cupola. This would supply an excess of oxygen above the combustion zone and would burn excessive amounts of the iron if it were not for the automatic action of the control. At this stage the blast-gate mechanism slowly closes to restore the balance between air flow and resistance, permitting melting to continue at a uniform rate until only the bed charge is left.

It is interesting to learn that, in addition to its regular control function, the use of automatic equipment in gray-iron cupola operations has other advantages. "Like other producers of fairly difficult castings," says Mr. J. L. Hutton, general manager of T. Shriver & Company, "we have long recognized the advantage of high spout temperatures. In our former operations these averaged 2,680°F. and were about as high as we dared obtain. Above this temperature level we encountered serious bursts of oxidation during periods in which more air was blown than could be consumed by the bed. We also found that occluded gases in the iron increased whenever excessive burning of the iron was going on. With constant blast-air control we know the depth of the combustion zone remains practically constant, and we find that we can operate between 2,700 and 2,720° without oxidation and with a minimum of occluded gases in the iron. The extra 30 or 40° has an appreciable effect on the fluidity of the iron, and is the means of still further reducing the percentage of defective castings, particularly for the smaller sizes of filter-press plates.

"From the start of our investigation of automatic blast equipment we have been primarily interested in the better control of the cupola and thus of the products of our foundry. We note with interest, however, that controlled blast has meant considerable savings in coke. By raising the iron-to-coke ratio from 8½:1 to 9½:1 we are saving some 600 pounds of coke daily. At current coke prices, this amounts to well over $1,000 saved in a 300-day year."

TREATMENT PLANT

The cinnabar (mercury sulphide) ore is reduced in a Herreschoff furnace, the heat driving off mercury gases which are condensed and purified. This plant, at the portal of the haulage tunnel, was almost completely rebuilt last summer following a fire. The mine has been worked intermittently for 69 years.

The Great Western Quicksilver Mine

Worthen Bradley

FIVE miles southwest of Middletown in Lake County, Calif., there is a historically interesting strategic metal operation—the Great Western quicksilver mine. This old property was operated first in 1873, and its 104,000-flask output ranks it second in the county (Sulphur Bank having passed it in recent years) and seventh in the state. Its most active period was from 1875 to 1899, when 85 per cent of the total was produced. A few thousand flasks were added in the early 1900's; but after 1909 the mine lay virtually idle for more than two decades.

In 1931 a company, headed by H. A. Miller and E. J. Bumsted, took a lease on the property from Richard Detert, the owner. It installed a reduction plant and built a camp at the portal of No. 2 Tunnel at the northwestern end of the mineral zone (the old plant and camp were 1,300 feet away at the southeastern end). The new plant included a 4-hearth Herreschoff furnace, the first mechanical furnace on

HANDLING CRUDE ORE

Ore trammed from the mine is dumped on a grizzly with 1-inch openings (upper picture) and oversize is sorted by hand, thus eliminating about one-fifth of the material mined as waste rock. Oversize worth saving is crushed and joins the fines passing through the grizzly to a bin. From the latter the material is fed by a bucket elevator (lower view) to a 20-ton conical bin above the furnace.

the property. The Miller-Bumsted organization produced 1,803 flasks largely from old stope fill and dumps, but was able to develop little or no new ore in place.

In 1936 the plant and equipment were sold to the Bradley Mining Company, of San Francisco, which also acquired the Detert lease. The new lessee engaged C. N. Schuette as consulting engineer, and has worked the property with fair success for the past 5½ years. The ore occurrences and their relationship to the serpentine and sedimentary wall rocks and to the fault and fracture pattern have been studied and are therefore better understood. Several thousand feet of development work has resulted in the finding of new ore and of some left by the preceding operators in the old stope areas. Sufficient material has been treated to yield an average monthly production of 43 flasks. It should be mentioned that open-cut development occasionally yields ore. A ½-yard Byers shovel is prospecting along the outcrop to the southeast.

The ore is cinnabar, usually existing in fracture zones in silica-carbonate rock which lies between silicified serpentine and a sandstone gouge and strikes northwest, with the serpentine constituting the west wall. The latter is also the hanging wall down to the No. 9 Level, where the dip changes from steep to vertical. Below No. 9 it becomes the foot wall. The silica-carbonate is 40 to 80 feet wide and is cross-cut, north to south, by a series of ore-bearing fracture zones. The ore rakes southeast and is being mined throughout a vertical range of 450 feet (including the old workings the vertical range is 1,150 feet and the distance along the strike is 2,000 feet). The fracture zones have an average length of 150 feet and the contained ore varies in width from less than an inch to 30 feet. The ore is narrower near the surface.

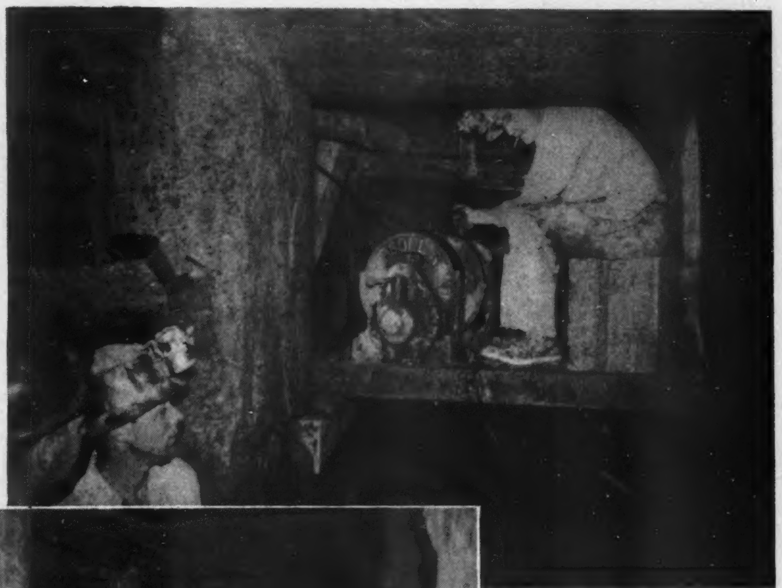
Rock for the reduction plant comes from development work and from square-set stoping done with an SAR-85 Stopehamer, the stopes being backfilled where possible. Three S-49 Jackhamers are employed for drifting, and winzes are sunk with the aid of HU and EU Utility hoists. Bits are of the detachable type with side holes and are resharpened at the Sulphur Bank Mine on an I-R bit grinder. Forty per cent Atlas Gelodyn No. 3 powder is used.

Compressed air is supplied by a Class ER-1, 12x10-inch Ingersoll-Rand machine run by a 60-hp., 440-volt General Electric motor, power being purchased from the Pacific Gas & Electric Company and transmitted to the property over a 11,000-volt line. The compressor is housed at the portal of No. 2 Tunnel, the haulage adit at plant level, and the air is delivered through a 2-inch pipe extending for 960 feet along the tunnel to the shaft station, down the shaft to the lower levels, and some 1,000 feet to the working faces on those levels.

The shaft is 6x7 feet in section, outside timbers, and is equipped with a ¾-ton skip handled by a 30-hp. single-drum electric hoist and with a ladderway. It inclines to the southeast at a 45° angle. No. 9 Level is 70 feet vertically below No. 2; X Level is 80 feet beneath No. 9; and 150, which is the lowest working level and is reached by two winzes from X, is 80 feet below the latter. It should be explained that no logical sequence has been followed in naming the levels. The first two bear the numbers given to them by the old-time operators, while the others were designated X and 150 by the present company.

The sump water level is held down by a 15-hp. Motorpump, and the winzes are dewatered with I-R sump pumps. There have been unusually wet winters, however, when the water has been known to rise faster than any pump of reasonable size could handle it. What seems to be a siphoning action suddenly takes place, unloading hitherto untapped old stopes into the working areas. Under circumstances such as these the pumps are pulled and X Level is "lost" for several weeks. During a particularly bad season, like that of 1940-41, No. 9 may also go under, and the period of submergence may last more than two months, to which must be added the time it takes to clean up and to retimber after the water recedes. This is admittedly a very unsatisfactory situation; but, short of a mile-long drainage tunnel, little can apparently be done about it.

Mining is highly selective. The underground men are experienced quicksilver miners and are relied upon to do their work with a minimum of dilution. The ore is trammed to the plant by hand in 1-ton cars and dumped over a grizzly with 1-inch spacings. The fines drop through to a 100-ton bin, while the oversize is handled by



UNDERGROUND SCENES

At the top right is an Ingersoll-Rand Size HU air hoist serving a winze that follows a streak of ore downward from the X Level. This picture and the one at the top left give an idea of the massiveness of some of the timbers placed in the mine by the early operators. They range up to 40 inches in diameter. It is not known why such heavy sets were used nor how they were put in place. A section of the inclined shaft is shown at the lower left. Hazen Crabtree, mine superintendent, is in the skip and on top of it is Worthen Bradley, author of this article and president of the Bradley Mining Company. Just above is C.N. Schuette of the mine staff pointing out streaks of cinnabar in the wall.

two operators on a sorting platform. They feed the ore by hand to a Wheeling 8x15-inch No. 2 jaw crusher which reduces it to ¾-inch size and drop the waste down a chute to a small bin for removal to a dump. During the first ten months of last year, 19 per cent of the mine-run rock was sorted out before furnacing.

From the crushed-ore bin the material is fed by chute and gate to an 8x10-inch bucket elevator which fills a 20-ton conical steel bin over the Herreschoff furnace. From the latter bin the ore is drawn on to the drying hearth at the rate of a ton an hour. After passing through the four hearths (the lower two are fired by No. 2 Hauck burners using diesel oil) the burned rock drops into an inclosed car and is trammed to the dump.

The gases that emerge from the top of the furnace are at a temperature of 600° F. and flow through an 8x8-inch dust collector to three parallel rows of vertical condenser pipes each 8 inches in diameter and 12 feet high. In each row are seventeen pipes, the first two being iron and the balance tile, which are joined alternately by U's at the top and Y's at the bottom, while alternate rows are cross-connected at the bottom by inclined tile pipes. As the products of condensation drop, they are washed down and through the latter pipes into stoneware pans set in a concrete trough. Beyond the pipes the gases enter successively a No. 30 American Blower Company straight-blade, rubber-covered fan which provides the mechanical draft for the condensing system, two 5x14-foot wood-stave tanks, and a 2-foot-diameter wood-stave stack. Incidentally, the original plant burned down and was rebuilt, with improvements, during the summer of 1941. The furnace withstood the fire and was rehabilitated; but nearly everything else had to be replaced.

The stoneware pans containing soot and quicksilver are dumped on an inclined steel table with turned-up edges. There the material is mixed with lime and hoed diligently so long as mercury can be worked out of it. The soot is returned to the furnace, and the quicksilver, flowing to one corner of the table, is run to a storage pot through a ¼-inch gooseneck pipe. Before the metal is bottled, the surface inside a floating iron ring is freed of dust by washing and wiping. That done, the mercury is dipped from the ring into a weighing bucket from which it is poured into iron flasks each of which holds 76 pounds.

The mine is situated at an elevation of 2,100 feet—No. 2 Portal—on the north slope of Mount St. Helena and in the midst of a good stand of fir and pine. The property therefore furnishes all the round timber and lagging required. In conclusion, it can be said that the Great Western is a typical example of a struggling quicksilver mine which, by virtue of close management and the present high price for the metal, is able to supply a small but important part of the country's war needs.

The author is indebted to C.N. Schuette and W. P. Busher tor several of the photographs, and to Mr. Schuette and Hazen Crabtree, the mine superintendent, for much of the data presented here.

AIR LINE AND BENDING RIG

The pipe at the right exemplifies the flexibility of the wrinkle method. It has a compound bend of 90 and 45°, respectively. The sharper bend has seven wrinkles, six at 13 and one at 12° spaced on 3-inch centers: the lower one has four wrinkles, three at 11 and one at 12°, also on 3-inch centers. The line is 4 inches in diameter and is made of extra-heavy black-iron pipe to deliver air at 250 pounds pressure per square inch. Above, left, is a rig with a jack-and-chain arrangement, showing how a piece of pipe is mounted for successive heating with oxyacetylene blowpipes and bending. The clamps used with nonferrous piping are at the right.

Pipes Made to Fit by Wrinkle-Bending

"TAILORING" pipe to fit requirements is done by a method called wrinkle-bending, which has been practiced for a number of years with iron pipe and has latterly been employed with success in connection with nonferrous pipe. The method, we are informed, is applicable to both light- and heavy-walled tubes and pipes, ranging in diameter from 1 to 22 inches for steel pipe, and can be performed as easily in the field for the fabrication of long gas or oil lines as in the shop.

Broadly, wrinkle-bending means that alternate bands on a length of pipe are heated and the pipe is bent, whereupon the heated area will upset to form a wrinkle. A predetermined number of wrinkles, each producing a definite amount of change in direction, completes the bend. The wrinkles vary in number, degree, and spacing with the angle and the outside radius of the bend; and, for the guidance of the workmen, the points at which they are to be made are plainly marked on the pipe.

The bending rigs employed differ somewhat in design but operate on the same principle. The end of the pipe nearest the area of curvature is firmly secured by holding-down clamps, while the other end is left free so that it can be raised by means of a jack-and-chain or pulley arrangement. So positioned, the upper half or two-thirds of the first of the series of bands indicated on the pipe is heated with one or two oxyacetylene blowpipes, depending on the diameter of the pipe. When at the right temperature, the free end is lifted, the pressure thus applied being sufficient to cause the metal in the heated zone to buckle. These operations are repeated until the required curvature is obtained. The work does not call for skilled labor; and, with a little practice, wrinkles can be formed at the rate of one in a minute or two for thin-walled pipe and in from 2½ to 3 minutes for heavy pipe.

In the case of copper, brass, aluminum, or other nonferrous pipe, which has not the strength of iron pipe, it is the practice to employ clamp jaws and a protractor. The former are placed one on each side of the wrinkle area and serve to confine the heat, to prevent the pipe from flattening out, and to control the shape and alignment of the wrinkle. The protractor is attached to the pipe by a chain and spring and is set to register the number of degrees change in direction that one wrinkle is to produce. When the bubble in the gauge is level, the operator knows that the wrinkle is completed. The clamps are then shifted to the next wrinkle position and the protractor is reset.

A number of advantages are claimed for wrinkle-bending pipe, not the least of

Photos, The Linde Air Products Company

which is the elimination of elbows and cut bends. Tests have shown that there is no more loss of head around a wrinkle than around a smooth bend. To this end it is preferable, in the case of a sharp curvature, to provide a series of slight rather than a few pronounced wrinkles. It has also been proved that the original thickness of the pipe wall remains the same except at the wrinkle—the point of compression—where it is actually slightly increased.

Reclaiming Scrap Metal

WHAT can be accomplished through the salvage of scrap metal when the work is conducted in a thoroughly efficient manner is emphasized by the activities of the Reclamation Division of the Westinghouse Electric & Manufacturing Company. Shavings, punchings, etc., are collected in the company's New Jersey and Pennsylvania plants and shipped to its Linhart Works near Pittsburgh, Pa., where 50 men are engaged in converting the material into ingot form.

Upon arriving at Linhart the sweepings are passed through a metallic separator for the removal of the iron. The nonferrous metal is then cleaned by washing it down an inclined table into a succession of buckets in which it settles while the dirt is carried away by the water. The mass or "metal hash," as the workers call it, is divided into pure aluminum, copper, and about 50 alloy categories, and each batch is placed in a revolving bucket where it is thoroughly mixed and tested to determine exactly what metals and how much of each it contains. Varying amounts of pure metals are next added to bring each up to the percentage specified for that particular alloy. Melting is done in gas-fired furnaces that are kept at a temperature of from 1,800 to 2,300°F.

The ingots poured weigh 100 pounds each and are marked for identification after their metal content has been checked by chemical analysis. They are used on the spot in the making of castings or are sent to the shops from which the raw material came originally, to that extent conserving the stock of new metal. But production figures are the best proof of the effectiveness of the economy program. The monthly output is close to 1,200,000 pounds, of which 120,000 pounds is aluminum. This is enough, according to W. J. Laird, head of the Reclamation Division, to build ten bombers every 30 days.

FROM SCRAP TO INGOTS

From top to bottom are shown the metallic separator which "holds" the iron in the metal sweepings on the conveyor and deposits the nonferrous material in a box from which it goes to the washing equipment. Batches of the clean metal, with proper percentages of pure metal added, are melted in gas-fired furnaces that look like huge teakettles. Each has a capacity of 20,000 pounds. At the left is a stack of ingots which are being chemically analyzed for classification.

Compressed Air in the War

IT HAS been emphasized many times that the present war is primarily one of machines. There are industrial fronts as well as combat fronts and those who profess to know say that the tide of battle will eventually be determined on the industrial fronts. Assuming that this is so, it is pretty generally agreed that American productive capacity, once it gets under full headway, will carry too much power for the Axis nations to handle.

This productive capacity is like a great river in flood stage. There is the main stream, running bank full, that sweeps everything before it. It gets its volume from the tributary streams, and they, in turn, are fed by countless rivulets that reach out over a huge drainage area. In similar manner, American industrial plants that are turning out war materials at a swiftly accelerating pace depend upon a far-reaching network of supply channels. Raw materials pour in from many sources, and they are taken in hand by innumerable intermediate factories that supply parts or accessories which are put together, for the most part, in final assembly plants. It is a flexible, highly adaptable system that can be expanded almost indefinitely, and in it lies the tremendous latent strength of the United States.

In this great industrial effort that is now taking form and that will continue to grow like a snowball rolling downhill, compressed air will play an essential part. The basis of much of our wartime manufacturing is minerals, both metallic and nonmetallic. Fortunately, our mineral wealth is great, and only a few vital materials must come from beyond our shores. Mines of many types are stepping up production schedules and can be depended upon to meet any demands made upon them. They can do this because they are adequately financed, capably managed, and staffed by skilled workmen who have at their command the most modern equipment and tools available. In the vanguard of these mechanisms are air-driven rock drills of American manufacture, concededly the most efficient, most durable and most economical in the world.

In steel mills, foundries, machine shops and countless other intermediate factories, as well as in the final assembly plants, compressed air performs thousands of essential services that contribute to the work done. It is likewise an indispensable aid in shipyards and airplane factories.

Compressed air drives numerous mechanisms aboard our fighting craft, and torpedoes are dispatched by it. In our new army organization, portable compressors and their complementary tools constitute an important part of the mechanized equipment.

In the preparations for safeguarding our seaboard cities against air raids, air-operated tools are speeding the work of constructing shelters and, where damage results, they will assist in demolition work and repairs. At sea, compressed air will enable divers to carry on valuable salvage operations.

It would require many pages to list in detail the uses to which compressed air will be put in the fighting zones and at home. It is comforting to know that American compressed-air equipment is the best obtainable and that it is being produced in quantities great enough to meet the demands of the emergency. In common with other machinery makers, the compressed-air industry has been on a wartime basis for many months, and a large part of its output has been going into the defense endeavor. Now its efforts will be further intensified, and the aim of management and workers alike will be to serve the nation to the limit of their capacity.

Help for Small Industries

THE Government is taking commendable steps to reduce the dislocations in industry that necessarily arise from the war program and to adjust those that have already occurred. The effort to make a place in the national armament movement for small firms that can no longer carry on their regular work because of shortages of material or other reasons is outstanding along this line.

Floyd B. Odlum, New York capitalist, utilities expert, and lawyer, who heads this endeavor for the Office of Production Management, has proved himself to be a militant champion of the little industrialist, and the plan that he has put in effect is bearing good results. At a time when hundreds of small manufacturers were despairing, Odlum initiated a simple but effective technique of helping them. He sent around the country a special train carrying exhibits of needed war materials and parts and accompanied by engineers who could answer questions relative to the display. In the thirty cities where this industrial clinic held forth, executives of ailing small concerns had an opportunity to look and to make inquiries. As a result, many of them have found out that their factories can be readily adapted to making some of the needed material.

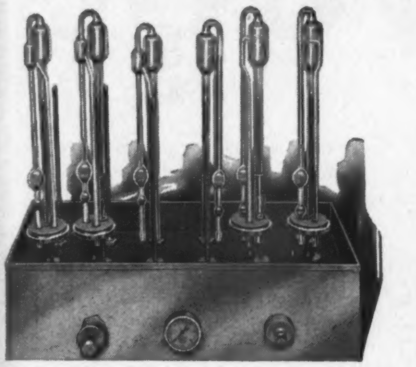
In most cases, the changeover from civilian to war-goods production has been far simpler than one would think, and it has been accomplished in remarkably quick time and at comparatively small cost. This is because there are similarities between the regular lines of work and some type of war goods, or because both can be turned out by the existing machinery. A few examples will make this clear.

A shoe factory in Massachusetts discovered that spindles used for shoe making were suitable for manufacturing a part for torpedoes. A producer of Venetian blinds in Boston found that he could adapt his plant for making folding wooden tables for the Army and wooden bows to hold up the canvas covering of Army trucks. A football manufacturer in Amsterdam, N.Y., is shifting to the production of gas masks and leather splints. A pin-making plant has turned to manufacturing needles for the Navy and wire work for parachutes. A factory equipped for spinning fine wire is now making gold braid for officers' uniforms. Jewelry manufacturers in New England are turning out electrical meters for the Signal Corps.

Industrial Notes

Goggle lenses that give 3-range vision —reading, arm's length, and distance— are made by the Univis Lens Company.

The accompanying picture shows an apparatus developed by the C. J. Tagliabue Manufacturing Company for the multiple cleaning and drying of kinematic viscosimeter tubes. They are placed over and supported by vertically disposed metal capillary tubes through which a



solution of carbon tetrachloride and petroleum naphtha is sprayed with air under pressure. When drained and clean, compressed air is admitted until the tubes are dry. The unit is equipped with a pressure gauge and with special valves that permit close control of the pressure and prevent the consumption of excessive quantities of solvent. Although primarily designed for this service, the apparatus is suitable for other glassware such as test tubes and pipettes and is being used to advantage in the laboratories of some of the country's largest oil refineries.

Royal Insulation Board is the trade name of a new cellular-rubber material that is being offered by the United States Rubber Company as a substitute for cork. It weighs about half as much as the latter and consists of thin, dense outer layers confining microscopic cells containing nitrogen gas. In addition to being rot- and oilproof, it is claimed to be resistant to moisture, acid, fire, and attack by vermin and termites. It is available in board form 1 inch thick and in two weights—4.5 and 5.5 pounds per cubic foot. The material can be cut with a knife or saw, surfaced with a planer, and bent to shape.

In erecting buildings for the New York City Housing Authority a contractor expedited operations by applying a special pavement-curing method to concrete floors and roofs. An area of approximately 2,000,000 square feet of reinforced slabs was involved, and the latter were coated, as soon as the surface had been troweled, with a thin, elastic membrane of asphalt emulsion. On windy days, or when rain threatened, a colorless compound was used to prevent staining brick walls. This work was done by means of a long-handled spray nozzle with air at 85 pounds pressure; and a total of 17,500 square feet was covered with 35 gallons of asphalt emulsion by one man in the course of an afternoon.

Liquid Wrench is sold in pint cans with nozzles and serves to loosen stuck studs, bolts, nuts, cover-plate connections, etc., for removal. The solution is said to penetrate and dissolve hard sealing materials and products of corrosion without attacking either the metals or the hands.

Finishing floors and walls with concrete mixed with Trinity white cement will give them light-reflecting surfaces, it is said. The material has been in use for some time in roadbuilding for marking traffic lanes and curbs. It is made by the Trinity Portland Cement Company.

Several of the copper smelters in the southwestern part of the United States are patching their reverberatory furnace roofs with silica slurry, says *Mineral Trade Notes*. Finely ground quartzite is used for this purpose and is bonded with about 3 per cent of bentonite to make it stick. By keeping the entire arch coated with this material the life of a roof is greatly lengthened.

There has recently been placed on the market a level indicator for standard 55-gallon steel drums that is said to keep continual check on the contents. It consists of a cork float mounted on wire rods and of a gauge that shows the fluid level at a glance. The apparatus is screwed into the regular faucet opening in the container, and the spigot is screwed into an opening in the body of the indicator. When a drum is empty the entire assembly is easily transferred to a full one. The U-C Indicator is suitable for use with any liquid dispensed in this manner.

What is said to be an entirely new type of engine has lately made trial runs on the tracks of the Swiss Federal Railways. It is described as a thermoelectric locomotive equipped with turbogenerators using fuel gas. The unit weighs 92 tons, develops 2,200 hp., and travels at the rate of 68.5 miles an hour. It is said to be especially suitable for fast train service in hilly country.

From Brazil comes the report that tomato-seed oil has great edible value because it has a high vitamin content and that it can also be put to industrial use as a drying agent and in the manufacture of varnish. Eighteen per cent of the oil can be extracted, leaving a nutritious residue or cake for animal consumption. It is estimated that 1,000,000 cases of tomatoes will yield about 100 tons of oil and 600 tons of cake.

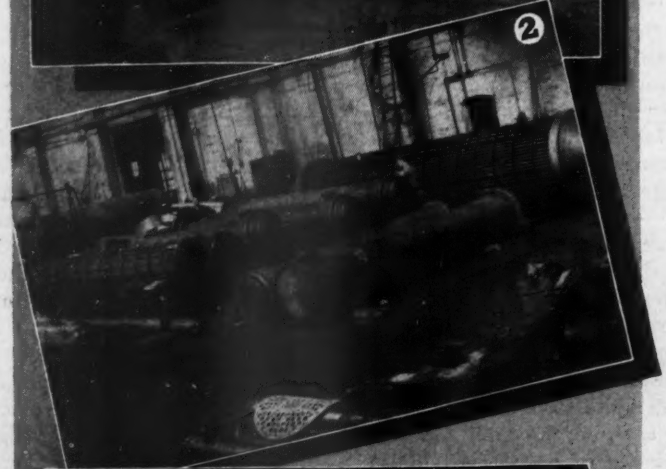
To study the mass effect of vitamins A and D against head colds, the 600 office workers of the Sharon, Penn., Westinghouse Electric & Manufacturing Company transformer division are serving as guinea pigs. Three times a day each one takes a chocolate-coated vitamin tablet obtainable free of charge at different points from wall dispensers mounted close to drinking fountains. This common ailment is accountable for the loss of many man-hours of work annually; and if the treatment proves to be an effective preventive it is to be introduced in all the company's plants.

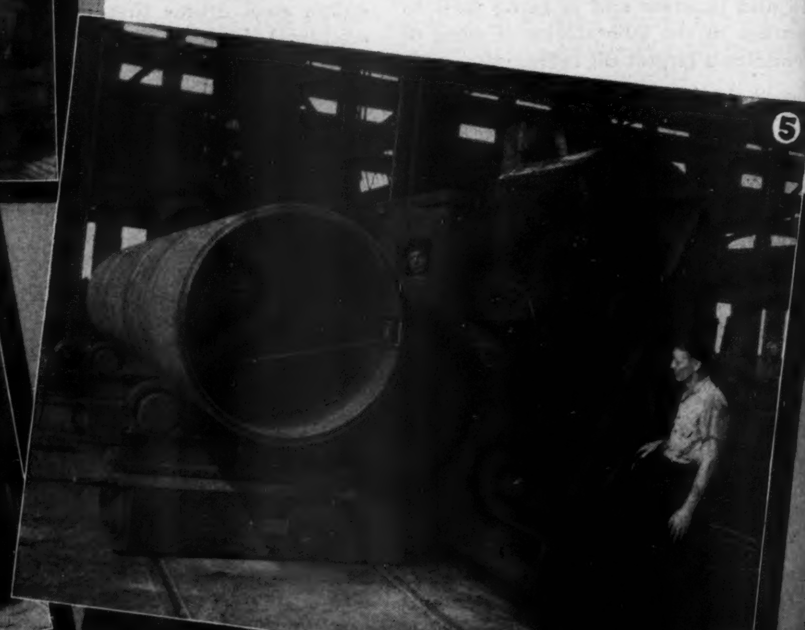
SOLDERING KIT IN A NUTSHELL

From left to right, these pictures tell the story of the Jigger, a new self-contained unit for soldering electric-wire splices. It is a waterproof, heat-generating shell in which the right amount of 50-50 solder and flux is hermetically sealed. The splice is pushed into this shell, which is lighted with a match and generates the temperature necessary to flow the solder into the splice. Dropping off the burnt shell completes the work, which is said to be smooth and well done. The product is sold by Jiggers, Inc., 215 W. Illinois Street, Chicago, Ill., which is offering free samples.

A.P.I.—A.S.M.E. and A.S.M.E. CODES • CARBON STEEL AND SPECIAL STEEL

WELDED PRODUCTS by Vogt





1 - 4′—0″ dia. x 7′—6″ dia. x 82′—5″ high Stabilizer Tower for a Texas Refinery. Fabricated to A.P.I.-A.S.M.E. Code, stress relieved and X-rayed. 250# working pressure.

2 - Heat Exchangers, for an Eastern Refinery, on the testing floor. Units have fusion welded Monel Metal shells and were built to customer's specifications.

3 - 48″ dia. x 22′—6″ long mud drum for a Vogt Water Tube Boiler designed to operate at 450# S.W.P. Fusion welded to A.S.M.E. Boiler Code.

4 - Battery of Absorption Columns in a Western Refinery. Units are 33″ dia. x 41′—0″ high and were stress relieved after welding.

5 - 400 KV Industrial X-ray unit in our plate welding department. Exographs of welded seams can be quickly made because of the special motor operated rolls and traveling carriages which are adjustable to vessels of any size.

VIEW OF
19 ACRE VOGT PLANT

HENRY VOGT MACHINE CO.
Incorporated
LOUISVILLE, KENTUCKY
BRANCH OFFICES: NEW YORK · PHILADELPHIA · CLEVELAND · CHICAGO · DALLAS